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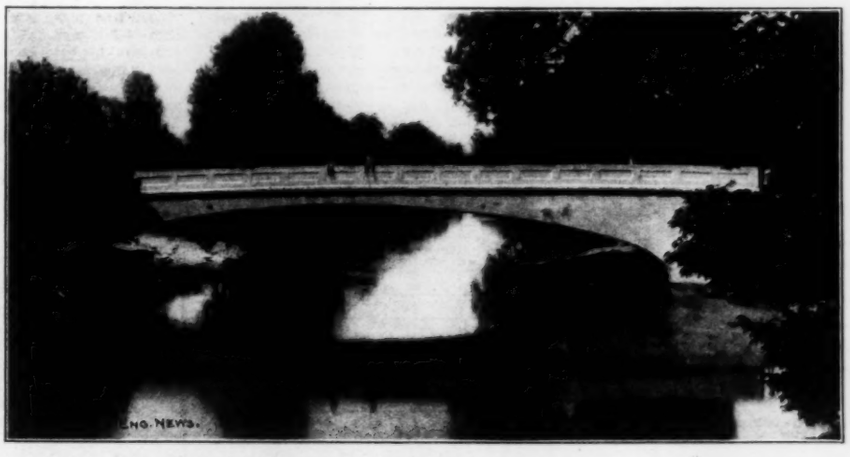
REINFORCED CONCRETE ARCH BRIDGE AT YORKTOWN, IND.

A reinforced concrete arch bridge of 95-ft. span, with the thrust resisted by a tie connecting the skewbacks across the bed of the stream, is illustrated by our first-page picture and the accompanying drawings. As will be recognized by some of our readers, the bridge is of the type patented by Mr. D. B. Luten and described in Engineering News of May 8, 1902. Its chief claims to importance are that it is the longest span of the Luten type ever erected; that it was built for about $100 less than the lowest bid for a steel truss bridge of the same span, and that construction was completed and the bridge thrown open for traffic in only a little more than 60 days after the award of the contract.

The rise of the arch from springing to crown is 11 ft. 1 in., or about one-ninth the span, the springing being approximately at low-water level, and the depth of water at middle of span about 4 ft. 6 ins., making a total height of opening of 15 ft. 7 ins. The thrust of the arch is resisted mainly by steel tie-rods extending from abutment to abutment beneath the bed of the stream, and embedded in a 6-in. concrete pavement. It is this pavement that renders the bridge flood-proof, since it absolutely prevents scouring of the bed of the stream or undermining of the abutments. The pavement is provided at both upstream and downstream edges with aprons, projecting downwards into the bed of the stream to prevent the pavement itself from being undermined. It was necessary to lay the pavement in over 5 ft. of water, a matter of no little difficulty since but one-half of the stream could be closed at one time. The footings were placed first on the gravel foundations at a depth of 4 to 5 ft. below low water, the upper surface of the footings being stepped upwards away from the stream just below the level of the pavement, so that the pavement-ties would project over the footings to meet the arch-rods and to be embedded in the ends of the arch rib. After placing the footings, cofferdams were built from one bank extending over a little more than half the span and the 1-in. tie rods laid in the pavement within the cofferdam with a welded eye turned on each rod to receive the rods for the other half of the span. The cofferdams were then reversed so as to enclose the other half-span and to lap over on the finished half, and the other half of the pavement was then completed. The junctions in the tie rods were formed by passing the ends of the free halves through the eyes, and giving each rod a complete turn around itself and then around the adjacent rod.

The forms for the arch ring were erected on this pavement, the centering consisting of 2 × 12-in. pieces sawed to the circular arcs of the arch, and supported on uprights transmitting the loading directly to the pavement. To avoid the rather unsatisfactory devices usually used in striking centers, that is, sand boxes, or wedges, the uprights were so proportioned by Gordon's formula for columns, that without bracing they would be too light to support the loading of concrete and earth filling that was to come upon them; but when braced at two points dividing the uprights approximately in thirds they would support their loading rigidly and without buckling. To strike the centers, then, it was only necessary to remove the sway bracing, and the uprights would buckle, letting the arch down easily without jar, until the full stresses in the rib should be developed.



REINFORCED CONCRETE HIGHWAY BRIDGE OF 95-FT. SPAN AT YORKTOWN, IND.

About 30 days after completion of the arch, the bracing was removed from the uprights, beginning at the ends of the span and working towards the middle. As the bracing was being removed the uprights gradually yielded, buckling from 4 to 6 ins. from the vertical, and allowing the arch to settle about ¼-in. at the crown. It is worth noting that the resistance of the uprights gradually decreases as the arch assumes its loading, so that the effect on the arch is practically the same as in releasing wedges, but under much better control. After the uprights had buckled, they were removed, one at a time selected at intervals, by driving them from beneath their caps, or if too tight, cutting them out. While no precautions were taken to prevent the collapse of the arch on the workmen, provision could easily be made where considered advisable, by first placing occasional heavy uprights, to receive and hold the arch in case of collapse. Such a safeguard could, however, be of value only in protecting the men, and watchfulness and care on their part would accomplish the same result without the auxiliary timbers.

The design of the uprights was in detail as follows: The uprights near the middle of the span were about 15 ft. long and were spaced 7 ft. apart across the stream and 3 ft. apart across the roadway. Each upright then was to support a loading of concrete of 7 ft. × 3 ft. × 26 ins. for the 26-in. rib, besides earth filling 1 ft. in depth × 7 ft. × 3 ft., or a total of about 9,000 lbs. Applying Gordon's formula for struts with free ends,

$$P = \frac{f S}{1 + \frac{l^2}{125\,h^2}}$$

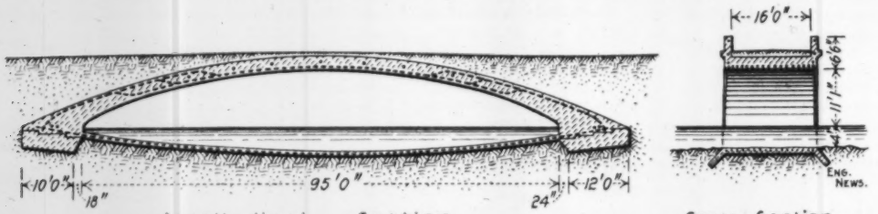
where P is the total load = 9,000 lbs., f is fiber stress for Oak = 1,600, l is length of strut in inches, h is least diameter of strut in inches, it was found that for a length of 15 ft., a 7 × 7-in. upright would be required to satisfy the formula, but for a length of 5 ft., which would result from bracing each strut at two points a 4 × 4-in. timber satisfied the formula. Therefore, 4 × 4-in. pieces were used, braced at two points, for the longest uprights.

The reinforcement of the arch rib consists primarily of ¾-in. steel rods of low tension steel spaced 6 ins. apart and arranged in series of single rods passing through the tension regions of the arch rib, that is near the intrados at the crown, and near the extrados at the haunches and abutments. Since the limits of the tensional regions cannot be determined with absolute accuracy, the reinforcing rods are arranged to cross the arch rib from intrados to extrados at points distributed over the area of probable minimum moment, one rod crossing the rib at a higher point, the next rod at a lower point, the next still lower, and the fourth rod back to parallel the first, and so on, thus reinforcing with series of single rods, both intrados and extrados, along the limited region of doubtful bending moment.

A secondary reinforcement of high tension steel was provided consisting of electrically welded wire netting attached to the rods of the primary system across the crown and extending through this crown-region of tension. The advantage of this combination is to reinforce the arch against its principal strains by a safe low tension steel procurable from stock at reasonable prices, and to increase the elasticity and strength of the concrete

in the crown tensional regions by the use of a high tension steel of expensive quality, but of small total cost. If there is any possibility of slipping of the concrete on the smooth round rods of the primary system, this netting would tend to prevent it. The netting used was of No. 6 × No. 10 wires spaced 3 ins. and 8 ins., respectively, the heavier wires running with the rib and parallel to the primary reinforcement.

The concrete of the arch rib and footings was all of the same grade and consisted of one part Portland cement to seven parts gravel and sand combined. The gravel was not screened, but was used as it came from a bar in the stream a short distance below.



SECTION SHOWING REINFORCEMENT OF 95-FT. ARCH AT YORKTOWN, IND.

The arch rib was built in parallel rings, the middle ring 12 ft. wide being placed first, and the two end rings of 3 ft. 6 ins. each, with spandrel and railings, following. Each ring was started at both footings simultaneously and was advanced continuously to meet at the crown; but on the middle ring, the foreman over-estimated his ability to secure workmen in the vicinity, and his force was exhausted while a 30-ft. gap still remained at the crown of this 12-ft. ring. The gap was closed a day later, however, with no especial precautions except to assure a radial joint and with results that were wholly satisfactory. The rings of the arch were bonded together by transverse rods across the roadway, bent upwards into the railings, seven over the crown and two at each abutment. The wire netting of the secondary reinforcement was also continuous across the entire roadway width of the bridge.

The concrete for the bridge was mixed on both banks and wheeled into place, a Ransome drum mixer of ½ cu. yd. capacity mixing at one end, and a gang of men mixing by shovel on a platform, at the other end. The earth filling was tamped over the finished arch and covered with a gravel roadway 12 ins. deep. The roadway, copings and railings, were cambered 12 ins. in the span of 95 ft. Upon striking the centers, 30 days after completion, the arch showed a settlement at the crown of about ¼ in.

The bridge described was built by the National Bridge Co., of Indianapolis, Ind., Daniel B. Luten, President, and we are indebted to Mr. Luten for the preceding description of the work.

PROSPECTING AND SAMPLING DEPOSITS OF RAW MATERIAL FOR PORTLAND CEMENT MANUFACTURE.

A task which frequently comes within the province of the civil engineer in developing the Portland cement industry is the prospecting, survey and sampling of possible deposits of raw material suitable for cement making. The best means for going about this work is seldom discussed in the technical press, and it will be of interest to some of our readers to quote briefly the instructions laid down by Mr. Albert V. Bleininger in a report to the Ohio Geological Survey, known as Bulletin III., on the "Manufacture of Hydraulic Cements." The following are selected excerpts from this report:

In investigating a new property for cement raw materials, it must be realized that the best methods of examination are of no value whatever unless the samples analyzed represent truly the character of the deposit. The guiding principle should invariably be that the less homogenous a deposit is, the more samples must be taken and the more carefully must the work be done. The writer could cite a considerable number of examples where neglect to make a proper preliminary examination has resulted in the ultimate loss of thousands of dollars.

In looking for a suitable clay material the experienced prospector makes use of all natural and artificial excavations, such as gullies, river banks, railroad cuts and quarries, for determining the character of the rocks in a certain locality. He watches every clay outcrop, and by applying the rudiments of geological knowledge is usually able to trace down the available clay beds. With the help of the geological reports and maps, and especially with the assistance of the excellent topographical survey maps of the U. S. Geological Survey the method of the attack is easily outlined.

If a random sample of a clay outcrop has shown a satisfactory composition and is promising in regard to its physical characteristics, an opening should be made into it, removing the surface clay, and a sample taken from the material within the bank. If this should likewise prove satisfactory, the bed is attacked at several places, examined, and finally a survey is made of a tract which affords enough material for the capacity of the factory which it is intended to erect. The area of the land is plotted and a topographical survey made. Now the map is divided into squares whose sides should range between 50 and 100 ft. in length, depending on the different thicknesses of the deposit. If the latter is thick, say 30 or 40 or more feet, the square should be taken with sides of about 50 ft. in length; if it is but several feet deep, they should be 100 ft., since the area to be examined in this case is so much larger. At the center of every square a test hole is sunk and the material brought up by the drill put aside for analysis. If at the depth drilled the clay is apparently of the same structure, color and general appearance, a sample need only be collected for every 10 ft. of depth; if, however, on drilling, various materials are found, a sample must be set aside for each different material.

By means of these drill holes sections can be plotted cutting the center of the area at right angles, one section passing through the deposit, say from east to west, and the other from north to south. After having plotted these sections to scale on a map the total amount of the different kinds of clay available, in cubic feet or cubic yards, can then be calculated with sufficient accuracy.

It is hardly necessary to state that the samples must be kept in suitable, tight receptacles, carefully labeled.

The accompanying section, Fig. 1, illustrates this method of prospecting; the section shows the presence of soil, soft clay, soft red shale and hard blue shale. Assuming that analysis has shown the soft red shale to be the most suitable and finding an average depth of 20 ft. of this material, we evidently have available in each square of 50 ft., 50 × 50 × 20 = 50,000 cu. ft. of clay. But this procedure has not only shown the amount of clay available, but also the variations in composition, since two samples are taken from a depth of 20 ft. This point should be well considered, as a knowledge of the composition of clays not only gives the prospective manufacturer accurate and valuable data, but is also of great help when manufacturing has been begun, since it tells the chemist what to expect in the future and may prevent some costly mistakes. When this is duly weighed, it surely ought to remove the last prejudice against the expenditure of the money necessary to carry on the preliminary survey.

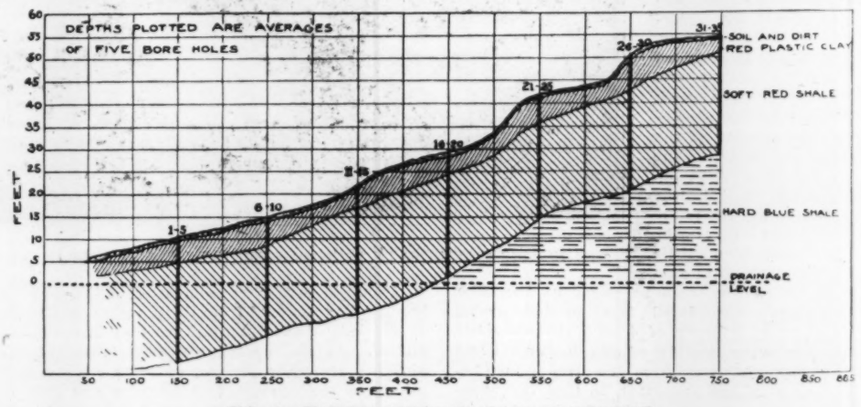


FIG. 1. TYPICAL SECTION OF CLAY DEPOSIT.

METHOD OF DRILLING IN CLAY DEPOSITS.

In the prospecting of clay property, the samples required can be obtained either by digging down through the strata to be examined or by drilling holes. It is evident, of course, that by digging prospecting holes, the samples obtained will be large in amount and permit of examining the deposit in the most thorough manner, and ultimately this must be done in every clay deposit even though it be opened up in, say, half a dozen places, at the extremities of the land available and in equal intervals between them. However, the cost of digging the holes is not inconsiderable and would not be resorted to until one is quite sure of his ground. Drilling, being so much cheaper, should be carried on during the preliminary survey, and may be done as follows:

(1) Boring with an auger. Applicable to clays that are free from stones and the softer grades of shale.
(2) Drilling with the churn drill.
(3) Combination of churn drill and auger.
(4) Core drilling, with a serrated pipe, applicable to rather soft material only.
(5) Core drilling with a pipe with sharpened edge at bottom, driven down.
(6) Combination of churn drill and pipe drill.
(7) Marl sampler, used in quite soft materials.

AUGER.—The auger is the most successful implement in the exploiting of clay and shales and should be used much more extensively than it is. A good 2-in. auger of best quality will answer in many cases.

Catlett* describes an auger which he has used in his prospecting work and which has given good service. The bit is made of steel or Swedish iron with a steel point twisted into a spiral, with an ultimate diameter of 2 ins. and a thickness of not less than ¼-in. The point is more effective when split. The auger proper should not be more than 13 ins. long, having four turns. This was welded on to the end of 18 ins. of 1-in. wrought iron pipe, on which screws were cut for connection.

CHURN DRILL.—The churn drill, used universally in quarries and wherever hard rocks are to be penetrated, is a most effective tool. It is usually made as a heavy iron rod with a piece of steel at the end about 12 ins. long, the cutting edge being about 2 ins. Its use is unnecessary in soft materials, but becomes imperative in hard rocks. In connection with the auger it forms a most useful combination, since it is used when going through hard rock and as soon as clay is reached the auger again becomes available. Such a drill was used by Mr. Catlett in connection with the auger described above. It was made of 1¼-ins. octagonal steel with a 2-in. cutting face, which was likewise welded on to 18 ins. of pipe cut for connections.

In addition other parts are found necessary: Ten feet of 1¼-in. iron pipe, threaded at either end for connection with 1-in. pipe. When connected with one of the drill bits this becomes a jumper for starting holes through hard material. It is also used when desired to give additional weight to the drill in going through rock. There are also needed sections of 1-in. pipe and connections. An iron handle must be used with a total length of 2 ft., arranged with a central eye for sliding up and down the pipe and with a set-screw for fastening it at any point. Other accessories are a sand pump consisting of one or two feet of 1-in. pipe with a simple leather valve and a string for raising or lowering it, two pairs of pipe tongs or two monkey pipe wrenches; as well as sundries; 25 ft. of tape, oil can, flat file and a water bucket.

The auger is worked by two men, turning it by means of a handle, and enough water is used to soften the material. Usually the auger brings up some material which is dry and unaffected. Every few minutes as the auger becomes full it is lifted out, scraped off and put down again. The handle is moved up and tightened by means of the set screws as the auger goes down.

*Trans. Am. Inst. Mining Eng., 1897.

... AND DRILL.—When hard materials are encountered the auger bit is screwed off and the drill bit put on, thus forming a churn drill, which may be used passing through the hard material, the auger being replaced as soon as the softer material is reached. The drill is used as seen in every quarry by being lifted and let fall, it being slightly turned at every stroke.

Catlett found that the best work was done on soft material, though no difficulty was experienced in

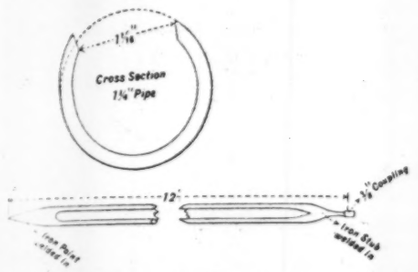


Fig. 2. Sampler for Marl Made by Robert G. Hunt & Co., Chicago, Ill.

going through hard rock. The cost increases materially at a depth of over 50 ft., but it is readily possible to go down 80 ft. and more. Down to 25 ft. two men can operate it; from that to 50 ft. a rough frame 15 to 20 ft. is needed for the third man to stand on. Above 50 ft. it is necessary to take off one or two of the top joints each time the auger or drill is lifted.

SERRATED PIPE.—In place of the auger a pipe, provided at the end with sharp teeth, may be used, which is forced down into the soft material by twisting a 2-ft. handle. The sample will be a plug filling the pipe, representing the section of the length of the pipe. Another contrivance is a pipe with sharpened edges at the end, which is driven into the ground. In both samplers the plug of the material is, of course, forced out, another section of pipe connected with the first pipe and again started down. Both of them can be used more effectively in connection with a churn drill, which is able to cut through any hard material that may be met.

removed and the sample taken from the pipe. A good sample can in this way be taken down to a depth of 18 ft. In order to cause the pipe to be forced down with greater ease it is best to sharpen the bottom edge.

SAMPLING LIMESTONE AND CEMENT ROCK.

In working with these harder rocks the churn drill is indispensable, it being worked either by hand or by power. In every case it will pay to obtain the service of a professional driller, such as are found in every district. At a comparatively small depth, drill holes are rapidly put through limestone material with a power drill.

If the rock to be sampled is in a quarry or other exposure, a vertical channel should be cut into the face, from top to bottom, sufficiently deep to remove all weathered rock, so that the sample obtained may be a true one. By drilling and the proper use of explosives such work can be carried on quite rapidly, but should in every case be done under the guidance of an experienced quarryman. For rapid work the diamond drill has given very good results.

In preparing samples for analytical work it goes without saying that great pains must be taken in order that they be average samples. Unless care it taken to do this, the entire work is of little or no value. The original sample should always be as large as possible and the entire quantity should be crushed together to 8 mesh and then intimately mixed and quartered down to about 10 lbs. This should be again ground so that it will pass a 20 mesh sieve, and again quartered down until the amount for a laboratory test has been obtained, about 500 grams, which must then be put through a 10 mesh sieve. One cannot be too careful or painstaking in this preliminary work, as its thoroughness governs the value of all subsequent work.

The Ohio Geological Survey carried on the sampling as follows: The samples came from the field in sacks, provided with pasteboard tags on the outside and wooden tags on the inside of each sack, the weight varying from 50 to 150 lbs. Wherever necessary the sample was dried on a hot plate dryer and then crushed by means of a small jaw crusher; usually the entire sample was run through in this manner, if the sample was a large one. The material was now thoroughly mixed, it being fine enough to pass through an 8 mesh screen. If the sample was less than 45 lbs., all of it was put into a specially designed dry ball-mill and of course in this case it was not necessary to mix it before putting in the mill. This

THE MISSISSIPPI RIVER CANTILEVER BRIDGE AT THEBES, ILL.

One of the most notable bridges in the United States will soon be opened for traffic across the Mississippi River at Thebes, Ill. Fig. 1 is a general elevation of this bridge. As will be seen, it consists of five spans: a channel span of 671 ft., two intermediate spans of 521 ft. 2 ins. each, and two shore spans of 518 ft. 6 ins. each. This steel structure is flanked at each end by an approach composed of concrete arches, and by approach lines of railway on earth embankments. Summarized briefly, the total cost of the work will be about as follows: Steel superstructure, $1,400,000; piers and foundations, $600,000; viaduct approaches, $300,000; earthwork approaches, $280,000, and track and trackwork, yards, etc., $220,000, which sums make a total of $2,800,000.

The Thebes bridge and its connecting lines have been built by the Southern Illinois & Missouri Bridge Co., the stockholders in which are the Illinois Central, the Chicago & Eastern Illinois, the St. Louis Southwestern, and the St. Louis, Iron Mountain & Southern railway companies. They furnish a connection between the lines of these companies on the opposite banks of the river; at present this connection is furnished by a car ferry between Thebes, Ill., and Gray's Point, Mo. The engineers of the work are Mr. Ralph Modjeski, M. Am. Soc. C. E., and Mr. Alfred Noble, M. Am. Soc. C. E., who, under the firm name of Noble & Modjeski, are chief engineers of the bridge company. Mr. W. E. Angier, M. Am. Soc. C. E., is Resident Engineer. The contractors for the different portions of the work were as follows: Grading the approaches, McArthur Bros., of Chicago; concrete approach viaducts, J. S. Paterson Construction Co., of Indianapolis; pier foundations and piers, C. Macdonald & Co., of New York; steel superstructure, American Bridge Co., of New York and Chicago.

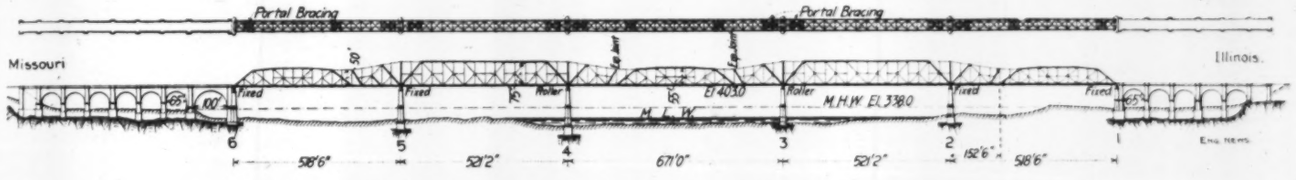


FIG. 1. GENERAL ELEVATION OF CANTILEVER BRIDGE OVER THE MISSISSIPPI RIVER AT THEBES, ILL.

Whenever the material is very soft, as is the case with marl and marl clays, quite a number of devices are being used for doing this work and the most of them can be made by any mechanic without much trouble.

HUNT SAMPLER.—One sampler* offered on the market is that manufactured by Robert G. Hunt & Co., Chicago, Ill. It is a piece of steel tube about 18 ins. long, slit longitudinally. Fig. 2. The end entering the marl is capped and pointed with steel so that it will penetrate more easily. To the other end there is attached a longer or shorter rod, which can be turned by means of a handle. The two edges running lengthwise are sharp, so as to cut the marl. When the tool has been forced down to the depth desired it is turned half around, filling it with a clean swath of marl its whole length. Thus a perfect sample of the marl throughout the length of the sampler is obtained.

LIQUID MARL SAMPLER.—For marls almost in the liquid state the Geological Survey of Michigan used a modification of the Farr marl sampler. The construction of this tool is readily understood from Fig. 3, and it is used as follows:

The plug is first held firmly against the mouth of the pipe by means of the rod and the whole tool shoved down the desired length. Now the pipe is raised, holding the

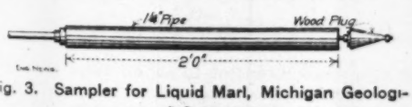


Fig. 3. Sampler for Liquid Marl, Michigan Geological Survey.

rod stationary, and is then shoved down to its former level, being forced tight against the shoulder of the plug. Both are now raised to the surface, the rod and plug

machine, made of chilled cast iron, proved extremely valuable in this work, since it not only ground the 8 mesh material to any desired fineness, but at the same time it produced a sample almost ideal as to uniformity. The grinding was done by Greenland pebbles, which, of course, introduced some silica, but so small in amount that it could be safely neglected. The usual charge of the mill was from 40 to 50 lbs. When a charge was ground the lid of the machine was removed and the flint balls, together with the ground material, dumped into a long box placed beneath the mill. From this box the whole charge was shoveled onto a heavy screen consisting of iron rods, forming about 1 in. mesh. This screen, about 3 ft. by 3 ft. in size, was placed within a box 15 ins. deep and 3 ft. sq. on the inside, and it was let down into the box about 5 ins., so there was a space of about 10 ins. depth beneath the screen. A smaller flat box was placed within the large box, under the screen, before the mill charge was shoveled onto the grating. The latter was just close enough to keep back the flint pebbles, while the ground material dropped into the box below. This was found to work very well, and it was a simple matter to prepare batches of limestone samples, or clay, or experimental cement mixtures. Clinker also was ground on this mill. In grinding clays or shales these must be thoroughly dry or the material will stick to the pebbles. In some cases it may even be necessary to apply a gas flame to the outside shell of the mill while it is running, to prevent the "pasteing" of the charge. The mill makes about 27 revolutions per minute and the power required to run it is quite trifling.

The samples thus obtained are thoroughly homogeneous and any portion of the ground mixture is a true average.

Though every laboratory is not in possession of such an outfit, similar mills, though small, may be constructed or bought with comparatively little expense. A small porcelain lined ball-mill driven by an electric or water motor will be found a valuable accessory of every technical laboratory.

CONCRETE APPROACHES.—The bridge is flanked at each end by a concrete viaduct, and these are shown in Figs. 2 and 3. The one on the east side has five semicircular arch spans of 65 ft., and the third pier from the river is an "abutment" pier of larger size than the others, being capable of resisting the dead load thrust of the arch on one side. The viaduct on the west side has six spans of 65 ft. and one of 100 ft.; the shore pier of the 100-ft. span is an abutment pier, as is the third pier from it. The copings and parapet walls were built in sections (in place), being bonded to the spandrel walls by steel rods. The width between parapet walls is 26 ft. 10½ ins. at the top, and 25 ft. at the level of base of rail. The width between spandrel walls is 20 ft. at the top, but the walls increase in thickness so that the space between them over the piers is 8 ft. in the larger piers and 10 ft. in the smaller piers. The space between the walls is filled with red gravel, compacted by flooding; the surface of this filling is sloped down from the middle of the arches to the piers and from the sides to the center. In the longitudinal valley is laid a line of 6-in. drain tile, connecting with a 6-in. vertical drain in the middle of each pier, with outlets at the ground level. Water passing through the filling is also drained by the same vertical pipes by means of catch-basins covered with gratings and large stones. The details of construction are clearly shown in Fig. 3.

The Kelly-Atkinson Construction Co., of Chicago, have the sub-contract for erection of superstructure.

*Geological Survey of Michigan, Vol. VIII, Part III, page 12. Marl and Its Applications to the Manufacture of Portland Cement, D. J. Hale and Others.

The arches are 3 ft. 3 ins. thick at the crown (4 ft. 6 ins. for the 100-ft. span), and have a radius of 32 ft. 6 ins. on the intrados and 40 ft. 5 11-16 ins. on the extrados. Over the middle of each pier is a 1-in. vertical expansion joint in the spandrel wall. These joints are coated with asphalt and filled with asbestos to exclude dirt. The tops of the arches and piers and the inner

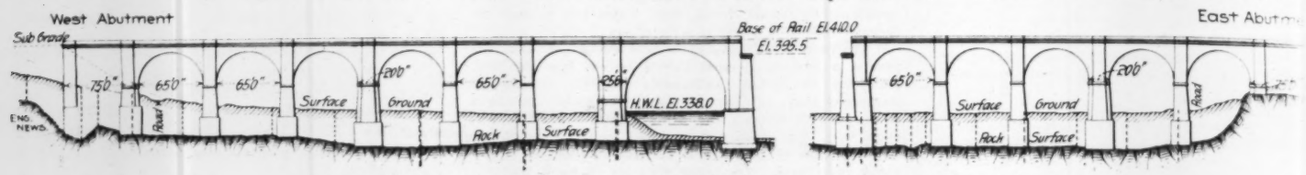
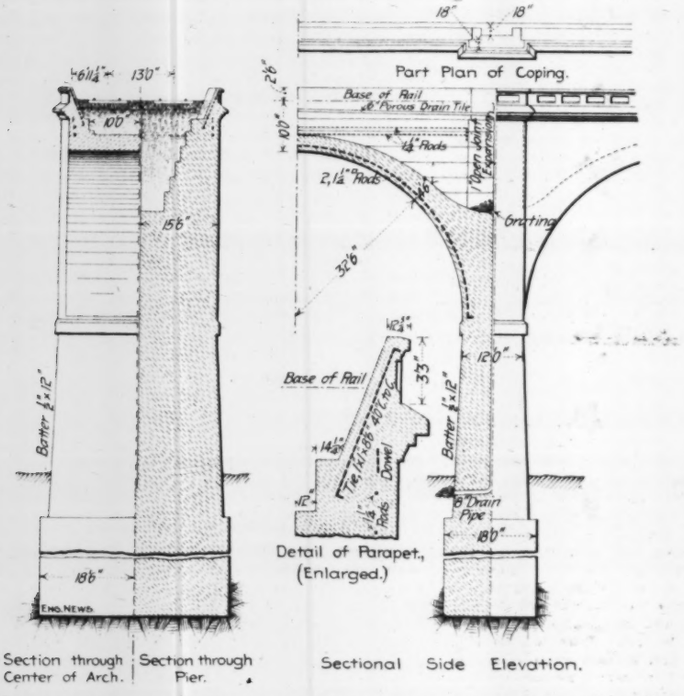
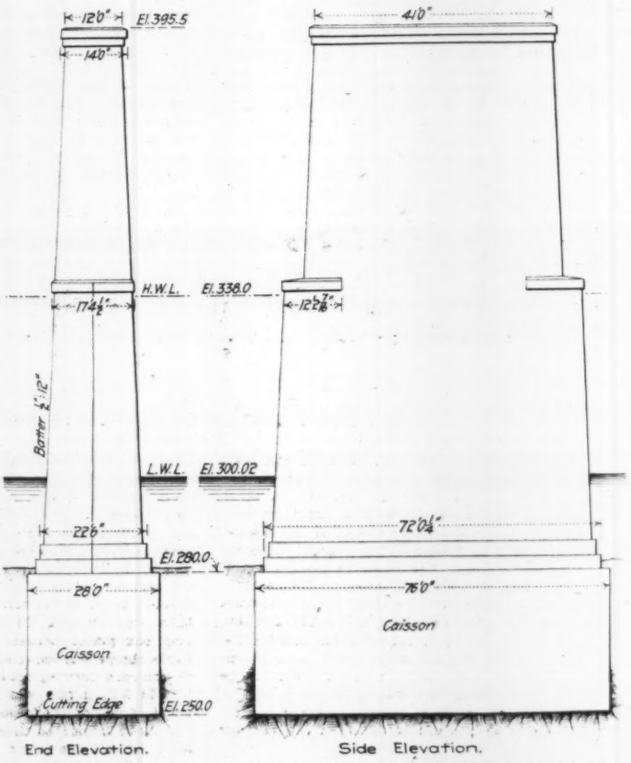


FIG. 2. CONCRETE APPROACH VIADUCTS OF THE THEBES BRIDGE.

faces of the spandrel walls are covered with a waterproof coating of burlap and Cimmerian asphalt composition.

In order to prevent cracking at the face, two 1¼-in. steel rods are embedded in the concrete on each side, close to the intrados of the arch; two similar rods are placed horizontally in the spandrel walls, just below the coping. There is no steel reinforcement for strength, this being considered unnecessary with semicircular arches. The concrete above ground is composed of Portland cement, sand and broken limestone in the following proportions, by volume: foundations, 1 : 2 : 5 for 1 ft. in thickness at the bottom, and





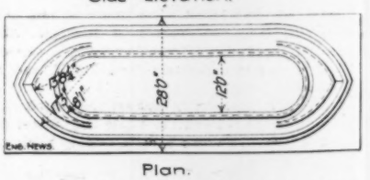


FIG. 3. DETAILS OF CONCRETE ARCH VIADUCTS, THEBES BRIDGE.

FIG. 4. PIER NO. 4; THEBES BRIDGE.

1: 3: 7 for the remainder; piers, 1: 2½: 6; arches and spandrel walls, 1 : 2 : 5; copings and parapet walls, 1 : 2 : 4.

BRIDGE PIERS.—The steel superstructure is carried by six piers, including the two abutment or end piers, at the ends of the approach viaducts. The piers are of concrete, faced with Romona oolithic limestone; but that portion of each end pier which constitutes a part of the viaduct is without masonry facing, so as to harmonize with the remainder of the viaduct. Pier No. 6, however, is faced with stone all around below the springing line of the 100-ft. arch for the reason that it stands in the river channel. The backing for three courses below the coping, however, is of stone. The face stones are anchored to the concrete by 1⅛-in. steel rods, and in certain parts the courses are connected by vertical steel dowels. The specifications provided that the face stones should be laid in regular courses: copings to be 27 ins. thick; belt courses, One of the piers (Pier No. 4) is shown in Fig. 4.

The foundations for piers Nos. 1 to 5 were put down by the pneumatic caisson system. At Pier No. 6, on the Missouri shore, the rock is so near the surface that the foundation was built in open excavation. The bottom of the deepest foundation (at Pier No. 4) is 50 ft. below mean low-water level. As the bottom of the foundation for Pier No. 3 was to be only about 20 ft. below low-water level, it was at first proposed to fill the caisson with concrete to a thickness of 6 ft., and after allowing this to set for seven days, to remove the top of the caisson and complete the work in the open air. This plan was changed, however, on account of high water; the roof was left in, and the caisson was sunk deeper than originally intended.

Owing to the broken and fissured character of the rock, and to the numerous large boulders encountered, the foundation work was slow and difficult, and a considerable amount of blasting had to be done inside the caissons. No accident resulted from this, however. When the caissons had been sunk to their final position, they were filled with concrete, a mixture of 1 : 2 : 3 being used for a thickness of 2 ft. at the bottom, and a mixture of 1 : 2½ : 5 for the upper part.

The caisson for Pier No. 4 (with the deepest foundation) was 30 ft. high. The walls of the working chamber had three thicknesses of timber 12 × 12 ins., two being horizontal and the middle one vertical. The inside had a single sheathing or lining of vertical planks, and the outside had a double sheathing of diagonal and vertical p... all 3 × 12 ins. The upstream edges were ... tected by ½-in. plates 24 ins. wide riveted ... angle iron for the corner. The cutting edge ... formed by a stick 12 × 18 ins., and a beveled ... tom piece 4 × 8 ins. The roof had two cours... timbers 12 × 12 ins., and two layers of 3 × ... plank between them, with ceiling of plank... 12 ins., and outside sheating of the two layer... 3 × 12 ins. The timbers were put together ... drift bolts. The interior of the chamber ... braced by heavy longitudinal and tran... timbers 16 × 16 ins., the ends of which were ... tailed into the sides and ends. In the roof ... three 36-in. openings for air locks, for the u... of the men and for handling materials. Above the roof was open cribbing, with sides of 12 × 12-in. vertical timbers and 6 × 12-in. horizontal timbers, sheathed on the outside the same as for the lower portion. The cribbing was anchored to the bottom timbers of the working chambers by vertical steel rods 1½ and 2 ins. in diameter. All seams in the caissons exposed to air or water pressure were calked with oakum.

STEEL STRUCTURE.—It will be seen by reference to Fig. 1 that the steel structure is symmetrical about its middle; spans of the same type are identical, thus simplifying both the shop work and the erection. The steelwork was designed for the following live loads: For the floor system 50,000 lbs. concentrated load and 5,000 lbs.

rm load per foot of track, i. e., 10,000 lbs. rm load per foot of bridge; for the trusses, of the loads assumed for the floor system; wind stresses, 1,000 lbs. per lineal foot of ge. The forms of the several trusses and main dimensions are shown by Fig. 1, and require no explanation.

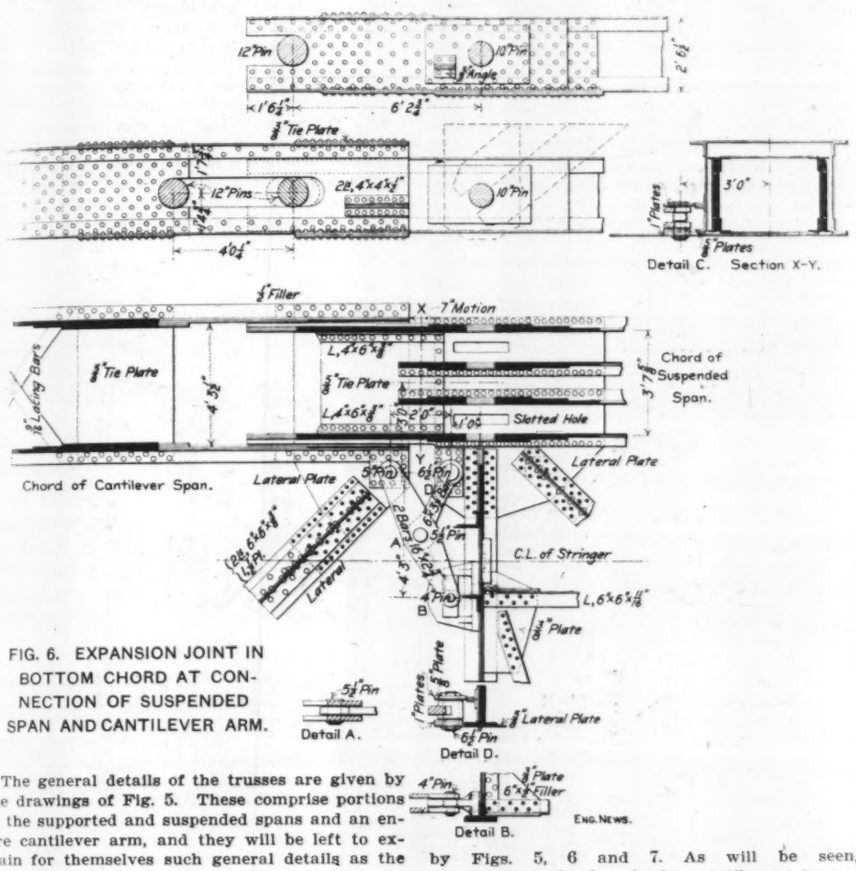


FIG. 6. EXPANSION JOINT IN BOTTOM CHORD AT CONNECTION OF SUSPENDED SPAN AND CANTILEVER ARM.

The general details of the trusses are given by the drawings of Fig. 5. These comprise portions of the supported and suspended spans and an entire cantilever arm, and they will be left to explain for themselves such general details as the composition and dimensions of the several members and their connections. It should be noted that the drawings show the portal and sway bracing of the supported span alone; all the spans had this same type of bracing at portals and intermediate panel points. The lateral bracing is sufficiently indicated as to form and make-up by the drawings. The chief feature of interest to be noted in connection with it is in the cantilever arm, where the web members are extended beyond the top chord pin holes to receive the lateral plates. The floor construction calls for no explanation, except to note that the ties are laid directly on the stringers, 5 ins. apart. The track rails weigh 85 lbs. per yard; outside of each there is an 8 × 8-in. guard timber, notched onto all ties and bolted to alternate ties, and inside each there is an angle-iron guard rail with its face 8 ins. from the head of the track rail.

The special details that demand notice are brought about by the connections of the cantilever arms with the supported and the suspended spans. The chords of the supported span are extended beyond the end pin holes to receive the pins by which the cantilever arm is attached. It will be noted that the same arrangement is employed where the bottom chord of the suspended span changes from a riveted box section to eye-bars for the four middle panels. Coming back to the end panel of the supported span, it will be observed that the tension diagonal is made up in an unusual manner; the lower half consists of ten eye-bars, riveted together in sets of two and three bars, so as to form four bars, and the upper half consists of two links of eye-bars, the connecting pin of which is tied to the top chord to prevent sagging.

The special detail of most interest is at the connection of the suspended span to the cantilever arm. The bridge structure is continuous throughout, and has fixed bearings at piers 1, 2, 5 and 6, and roller bearings at piers 3 and 4. To provide for movements due to expansion and contraction, expansion joints are provided at the connections of the suspended spans and cantilever arms. The arrangement of these joints is shown by Figs. 5, 6 and 7. As will be seen, the bottom chords of the cantilever trusses slip over the corresponding chords of the suspended trusses. To prevent these slip joints from bending, due to lateral wind pressure, a link connection of the form shown in diagram by Fig. 5 and in detail by Fig. 6 is provided. This link permits free movement in the direction of the line of the bridge, but holds the trusses rigid in respect to each other and against transverse movement. To provide for movement in the floor stringers, connecting panel points, LC_4 and LS_5, these stringers are connected to floor beam LS_5 by the link arrangement shown by Fig. 7. These links, one at each stringer, hold the free ends of the stringers from dropping vertically, while permitting free movement in the direction of the axis of the bridges. The same detail was designed by Mr. Modjeski for the Memphis Bridge.

MATERIALS AND WORKMANSHIP.—The material used was open-hearth steel, classified as medium steel, pin steel and soft steel, specified to have the following qualities:

Property.	Medium steel, lbs. sq. in.	Pin steel, lbs. sq. in.	Soft steel, lbs. sq. in.
Ultimate strength	62 to 70,000	62 to 70,000	52 to 60,000
Min. elastic limit	35,000	35,000	30,000
Elongation in 8 ins.	22%	18%	26%
Reduction of area	44%	36%	52%

The specifications for workmanship were in abstract as follows:

RIVETED WORK.—All material must be perfectly straightened. Mill straightening will not be considered as sufficient. The templates shall not be applied to any material unless it is perfectly straight. They must lay flat without any distortion while the marking is being made.

All material in tension members and in members with reversible stresses where the tension unit stress exceeds the compression unit stress shall be designated at "tension material," and shall be treated as follows: Material 13-16-in. thick or less may be punched through a die of a diameter 7-32-in. less than the diameter of the finished hole; each plate or shape shall then be reamed separately to a diameter ¼-in. less than the diameter of the finished hole; the final reaming to be done after assembling. Or, at the option of the contractor, such material may be drilled solid with the various pieces assembled. Tension material over 13-16-in. thick shall be drilled solid.

All material in compression and all material not falling under the classification of the former paragraph shall be designated as "compression material," and shall be treated as follows: Material 1-in. thick or less may be either drilled solid or punched with a die of a diameter 7-32-in. less than the diameter of the finished hole, and reamed to full size when assembled. No punching will be allowed in material over 1-in. thick.

The punching in the tension material must be sufficiently accurate to permit the finished holes to be perfectly cylindrical and true. The punching in compression material must be sufficiently accurate to permit at least 1-16-in. of metal to be taken out all around the hole by reaming.

Bottom flanges of stringers and floor beams shall be treated as tension material. Lateral and sway bracing, also lattice bars and angles and tie plates, shall be treated as compression material, as far as punching and reaming are concerned.

No drifting shall be allowed which would cause initial strains in any of the assembled pieces. The reaming and drilling shall be done in a neat manner, the tool being held at right angles to the surface of the metal. While reaming or drilling is being done, the different pieces shall be held firmly together by clamps or bolts applied at frequent intervals. In case this requirement is not complied with in a manner satisfactory to the engineer, the contractor may be required to take the various pieces apart after reaming and to clean and repaint the surfaces in contact.

After the pieces are reamed, every hole shall be gone over with a countersinking tool, cutting off the sharp edges of the hole, and making a fillet of about 1-16-in. under each rivet head. The diameter of the rivets will be such as to require, when heated, a slight pressure to force them into the hole. The size of the rivets shall be adjusted to fill this condition. Whenever possible, the riveting shall be done by power. The engineer may require of the manufacturer to procure special riveting machines to meet special positions. Riveting with percussion machines will not be considered as power riveting. All rivets shall have hemispherical heads of neat and workmanlike appearance, concentric with the axis of the rivet hole. They shall be well up against the metal. The rivets shall fill the holes and be absolutely tight. No calking or re-cupping will be allowed.

FORGED WORK.—All steel heated for the purpose of forging, bending or upsetting shall be subsequently annealed by heating to a dark red heat and allowing to cool slowly. The design of the eyebar heads may be determined by the contractor, provided this design is uniform throughout for each width of bar, and provided the head is strong enough to break the body of the bar. The head will never be more than 1-16-in. thicker than the body of the bar.

MACHINE WORK.—All sheared edges or ends of plates or shapes shall be planed or faced so as to take off at least ¼-in. of metal. No sheared or punched surface shall be left in the work. Curved edges may be chipped and filed unless specified to the contrary. The ends of riveted chords shall be faced after they are riveted up complete,

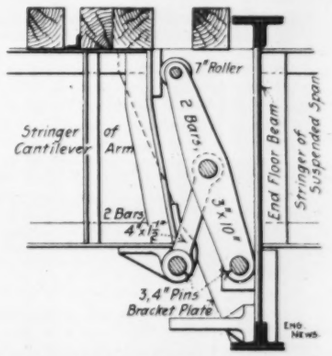


Fig. 7. Expansion Joint at Connection of Stringers of Cantilever Arm with End Floor Beam of Suspended Span.

except the projecting splice plates. The lengths shall be measured with iron standards. The chords shall be provided with suitable spacing blocks and clamps, especially near each end, to hold the plates and angles firmly in their proper relative positions while the ends are being faced. The chord sections shall be fitted together at the shops in lengths of at least 120 ft. When so fitted together there shall be no perceptible wind in this length. The reaming of the splices, as well as all other field con-

nections, shall be done with the different parts assembled. When this is impracticable, the connections shall be reamed through iron templets at least 1½ ins. thick. The diaphragms, latticing and tie plates in the four webbed chord sections must be riveted up complete before the pin-holes are bored. All pin-holes shall be bored with a sharp tool. A finishing cut shall always be taken. The finished pin-hole shall be perfectly smooth and polished. Roughness in a pin-hole will be sufficient reason for rejecting a whole member.

The distance between pin-holes shall be measured with an iron standard of the same temperature as the member. The plans show the distance between the centers of pin-holes; shop measurements shall be made between the bearing surfaces of tension or compression members, with a proper allowance for the diameter of the pin. Pin-holes shall be bored exactly square with the member and absolutely parallel with each other. The play in the pin-holes shall never exceed 1-50-in. for pins up to 8 ins. diameter and 1-32-in. for pins over 8 ins. diameter. Machine-fitted bolts must fill the holes with a driving fit. Pins over 6 ins. in diameter shall be bored through the center. All pins shall be accurately and smoothly turned to gage and shall be of full size throughout. The ends of stringers and floor-beams shall be squared in the facer. The end angles must be so fitted that the facing does not

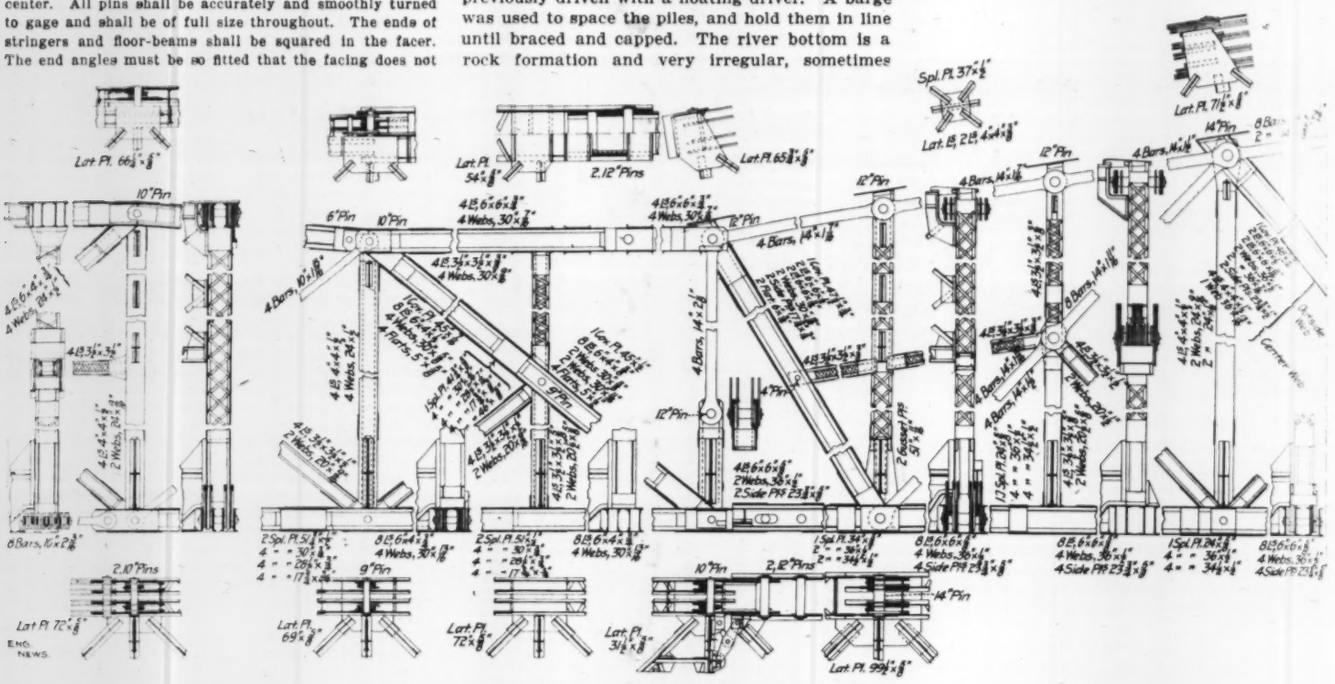


FIG. 5. DETAILS OF STEELWORK OF THEBES BRIDGE.

reduce the thickness of the angles by more than one-eighth of their original thickness. The cut shall extend over the whole surface of the angles.

EYEBARS.—Eyebars, after being annealed, shall be bored with a sharp tool at exact distances. The pin-holes shall be perfectly square with the face, and exactly on the axis of the body of the bar. Roughness in the pin-hole shall be sufficient reason for rejecting the bar. The bridge will be so designed that the largest eyebars can be pulled either to destruction, or up to 60,000 lbs. per sq. in. by the Phoenix Testing Machine, which has a capacity of 1,200 tons. The bars will be required to break in the body. When a bar breaks in the head, but develops 10% of elongation, another bar of the same size and lot shall be tested, the two tests being counted as one. If the average elongation of these two tests attains 12%, the test will be considered as satisfactory; provided, however, that no more than one bar of each group of three tests breaks in the head.

ERECTION.—The two shore spans on each side were erected on falsework, the bents and towers being arranged as shown in Fig. 8. The details are shown in Fig. 9, the cross-section being that of one of the 30 double bents. The 16 single bents are similar, but with three vertical posts and four piles under each chord, and three piles at the center. The timber was long-leaf yellow pine and Washington fir. The piles are of cypress and oak, 10 ins. diameter at the point and from 46 to 75 ft. in length.

The pile driver traveled over a runway built on the pile caps. It consisted of two derricks with masts 12 × 12 ins., 30 ft. long, spaced 32 ft. c. to c., and set on the front end of the sills. The sills on either side were two pieces 9 × 18 ins., 32 ft. long, spaced 12 ins. apart to allow the back stiff legs to be framed between them. The sills were braced laterally with planks 4 × 10 ins. and floored over. The masts were twin-braced with four pieces of 4 × 12-in. bracing. The booms were 12 × 12 ins., 44 ft. long, and from the top end of the booms were suspended swinging leads. In each set of leads was a drop hammer weighing 2,400 lbs., and these were operated by two double-drum hoisting engines on the back end of the frame. One drum was for operating the boom, the other drum for the hammer line. The spools were used for swinging the booms and handling the piles.

On the Illinois side (Fig. 8) the driving was started from the shore and carried out to pier 2 by the above machine. West of this pier, three bents were driven with a floating driver, and the other driver was moved around the pier on these bents and the balance of the piling to pier 3 driven with it. On the Missouri side, the driving was started from pier 4, three bents having been previously driven with a floating driver. A barge was used to space the piles, and hold them in line until braced and capped. The river bottom is a rock formation and very irregular, sometimes bare and sometimes covered with 6 to 8 ft. of sand in places, so that the penetration of the piling varied from 0 to 6 or 8 ft., except when a crevice would be encountered, when the penetration would be from 12 to 25 ft.

For erecting the top falsework, a rig was used that moved out over the top caps; it was built practically the same as the pile-driver rig already described, with the exception that it was not equipped with the leads. The bents were assembled on the pile caps, the top section first and on this the lower section. Then the bents were hoisted into position and braced, and the rig pulled ahead to put up the next and so on.

On the Illinois side, the yard room was along the right of way, near the concrete approach. On the Missouri side, the yard was located at Illmo, along a side track about three miles from the bridge. The unloading and handling of the material in the yards was accomplished by two self-propelling derrick cars in each yard.

The travelers used for the erection of the superstructure of the four spans built on falsework were of the familiar form shown in Fig. 9. The power was furnished by one six-spool and one eight-spool hoisting engine set on the traveler track behind the traveler. For the main falls, extra heavy four-sheave blocks were used, rigged with 1¾-in. manila rope. For the runners and secondary falls, 1½-in. manila rope was used. On the Illinois side, the material was taken out over the top, and the floor system and bottom chords of span 1 were erected first and then the bottom chords of span 2 were placed and riveted. The floor system and trusses were then erected complete for span 2; then the trusses comp[illegible] for span 1. On the Missouri side, the materi[illegible] was reloaded at Illmo and taken by work tra[illegible] to a transfer landing and loaded on a car [illegible] fer boat and taken by a tug to pier 4. It w[illegible] ere hoisted by means of a steel derrick to th[illegible] ck level and loaded on push cars and taken [illegible] the traveler to be set in position.

In regard to the camber of these sp[illegible] the chief engineer's office provided a camber [illegible] m, for condition of no stress. To the camb[illegible] ere given 2 ins. was added to allow for settlem[illegible] nd take-up in the joints of the falsework. [illegible] was ample for span 1, but for span 2 it [illegible] not enough, and caused a delay in driving [illegible] last hip pins. Therefore, in setting the cambe[illegible] ck- ing for span 4, instead of adding 2 ins. [illegible] ach point, at the center panel 3 ins. was ad[illegible] and graded down to 2 ins. for the first pan[illegible] int.

This was apparently the proper compensation to allow, for no trouble was experienced in driving any pin. A steel ram weighing 2,400 lbs. was used in driving the pins.

The specifications required that all main tension members should be driven with pneumatic compression riveters. This was done with three special "bull" riveters constructed on the alligator type for the work. Other riveting was done with pneumatic riveting hammers. Two separate compressor plants on either side of the river furnished the power for this work.

The erection of the channel span was accomplished by two overhead travelers, constructed as shown by Fig. 10, working from either side. These travelers are mounted on the top chords, and the material is brought out on the span and erected in place. This is the same for both sides of the river, the approach viaducts having been completed on the west side, so that the material can be brought in from Illmo yard over the tracks of the bridge company.

The erection was done by the Kelly-Atkinson Construction Co., of Chicago, and we are indebted to that company and Mr. F. C. Fisher, its engineer in charge, for plans and information relative to this part of the work. The American Bridge Co. had the contract for the superstructure. The engineers were Mr. Alfred Noble, M. Am. Soc. C. E., of New York, and Mr. Ralph Modjeski, M. Am. Soc. C. E., of Chicago, under the firm name of Noble & Modjeski.

TERMINAL AND YARD FACILITIES.—Owing to the large number of large railway systems which will be connected by this great

...e, there will be a large amount of switching ...red for the distribution of interchange cars. ...rovide for this, an extensive yard and division ...minal is being laid out by the St. Louis South-...ern Ry. at its connection with the bridge rail-... (on the Missouri side). A small town named ... is established here, and the terminal facili-... include a station, yardmaster's office, 19-stall ...dhouse with 70-ft. turntable, water tower, ...le track cinder pit 120 ft. long, coaling station ... 24 pockets, car repair tracks, oil and store ...es, and track scales. The freight yard will ... about 30 body tracks, spaced 14 ft. c. to c., ... the first yard track 18 ft. from the center ... the nearest main track. Most of the switches ...e No. 9 frogs, but No. 7 frogs are used for the ...y tracks of the yard. This yard was planned under the direction of Mr. M. L. Lynch, M. Am. Soc. C. E., Chief Engineer of the St. Louis Southwestern Ry. In connection with this road a yard has been graded just south of Illmo for 20 tracks 3,000 to 4,000 ft. long, and a few of these tracks are now being laid. This yard will be for handling the business of the bridge company, and forms part of its property.

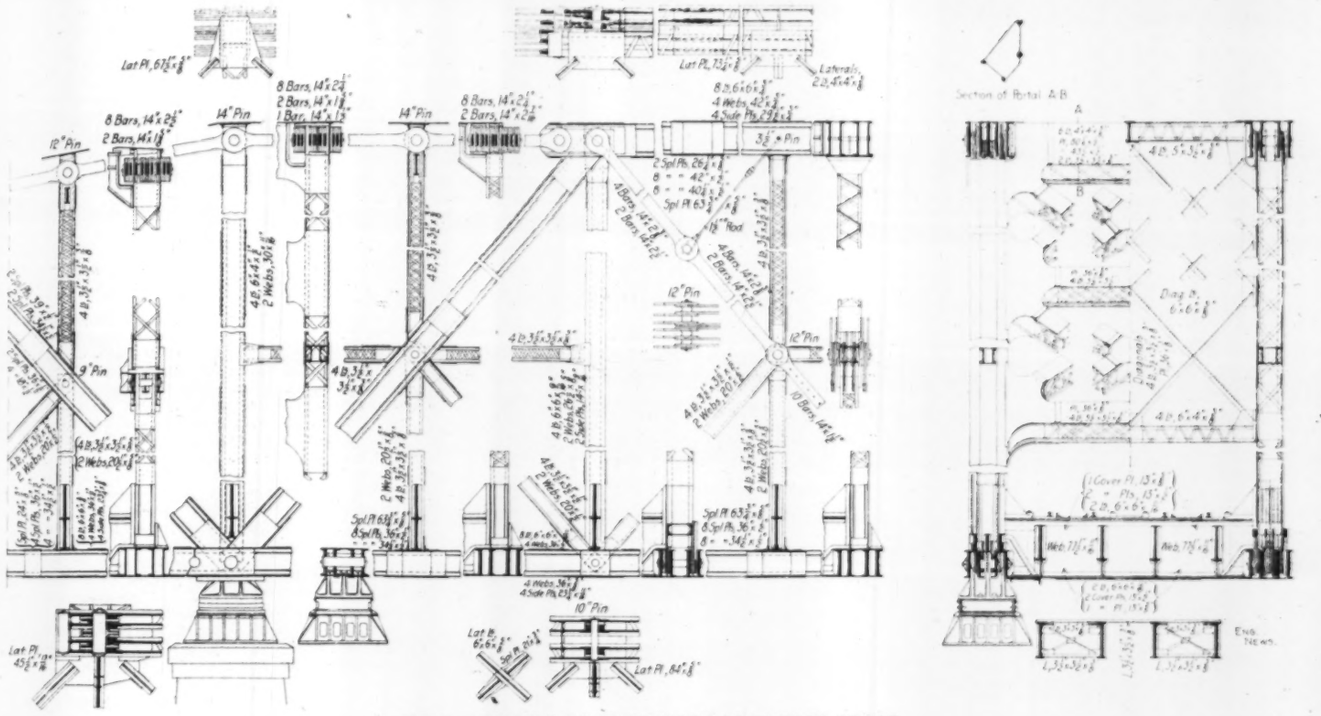


FIG. 5a. DETAILS OF STEELWORK OF THEBES BRIDGE.

THE PRESENT CONDITION OF ANALYTICAL CHEMISTRY.*

By W. F. Hillebrand.†

It is a natural and a justifiable belief that with the progress of time we learn to do better the things that a while since were new and strange—this both singly as individuals and collectively as nations. When the great advances our country has made in the domain of chemistry within the past twenty years are contrasted with the conditions obtaining before that time, particularly as regards facilities for acquiring a sound chemical education, it seems quite reasonable that we should feel that analytical chemistry has kept pace with the general advance, and that our chemists are now not only more numerous by far, but also, taking them collectively, more capable analysts than their predecessors. But it were unsafe to accept such a belief as fact without some stronger evidence in its support than the existence of a general law of progress.

It is difficult, if not impossible, to make comparisons that will admit of deciding favorably or adversely the point just raised. But happenings of the past two or three years have thrown a flood of light upon the present condition of analytical chemistry in some lines of technical work, and the illumination comes as a distinct shock to the recipient, who may justly ask: If the conditions are so in these branches, is there any reason to suppose them better in others?

When evidence is forced upon our attention, giving rise to doubt and uneasiness, it behooves us to examine the evidence with care and, if found convincing, especially if reinforced from varied sources, to face the problem boldly with a determination to ascertain the causes of failure and the proper remedies to be applied.

The evidence to which I have referred, it is needless to recapitulate at this time. Much of it has been presented in the reports of a committee of the New York Section of the Society of Chemical Industry bearing on the analysis of cements and copper slags. Additional testimony appears in the report, published in the Journal of our Society for December, 1904, of the Committee on Uniformity in Technical Analysis, of which I am chairman. Much might be added to that which has appeared in print. The volume of evidence is large and its character of such a kind as to force one to the unwilling belief that the frequent charges of bad work are fully substantiated. The causes for this condition are, however, but imperfectly understood, and until ascertained the corrective treatment cannot be outlined with any degree of precision.

It is nothing new or chemists to differ in their analyses of the same material, and they will never cease to differ by reason of human fallibility and the limitations of all analytical methods without exception, but unless two chemists are able to assay or analyze the same sample with results acceptable as a basis for buying and selling, the analysts suffer in the estimation of those interested in the transaction. If similar want of accord is of frequent occurrence, the burden of blame may be shifted and the art of analysis, even the science of chemistry itself, fall into disrepute among the unthinking. In any case the matter is one of grave concern in many ways, and merits the serious consideration of chemists as a body.

Many causes for such inability to arrive at concordant results have been set forth and discussed ofter by others, both here and abroad, notably by Messrs. Dudley and Pease, and Baron Jüptner von Johnstorff, with special reference to the iron and steel industry. The unsatisfactory conditions in iron and steel laboratories were not new then, for those interested had long been confronted by the most annoying and disturbing lack of agreement in the returns by different chemists. The same was doubtless true in other lines of work, though, because of the lesser magnitude of the industries involved, the notoriousness was less. What efforts were made through an international committee to correct the state of affairs as regarded iron and steel chemistry is matter of history, and need not be here entered upon. Neither will the long and still continuing work of the agricultural and food chemists at home and abroad to better their own condition by a close comparative study of methods and the selection of standards be more than alluded to, nor is it my object, on the basis of their results, to advocate the adoption and general use in technical lines of standard or uniform methods of analysis. My main object is to force upon the attention of chemists the seriousness of the present situation, a situation which is little creditable to our profession.

We may analyze the causes for the variations shown in the analyses of the same, or supposedly the same, samples, and, neglecting the inevitable personal factor, find that in certain cases the sampling was incorrect, in others that the water was bad, the reagents faulty, their effect on the glassware used greater than had been suspected, or that of several methods for reaching the same end one or more are of doubtful value unless used with that knowledge which can only come of long practice, sharpened by discriminating judgment. But in the ultimate analysis these distinct causes nearly all lead back to one stem root—some defect in the early education of the chemist—for which the institutions that are yearly sending forth young chemists supposedly fitted to do good work in their chosen lines, are responsible.

It will, of course, be asked: In what respect have their instructors failed toward these young men? A definite and comprehensive answer to this demand it is out of my power to give. I am pretty fully convinced, however, that the teaching of incorrect methods is neither wholly nor in large part to blame. The faults, if faults there be, are rather those of omission than of commission. Let me suggest a few possibilities and leave each one concerned to be his own judge of their fitness. In so doing I disclaim all thought of reflecting upon any particular individuals or educational institutions. Some may be, and doubtless are, less at fault than others, and the results are perhaps in most cases not due to ignorance or indifference so much as to causes quite beyond their control. The condition is none the less existent and demands earnest attention. I speak, of course, not as an educator and, therefore, not as one qualified to dictate in the matter of ways and means. But, I repeat, a certain condition confronts us, and this condition needs a remedy. Where there is a determined will backed by a united sentiment, most obstacles can be overcome with time. It is this determined will and sentiment that I would help to arouse to action, not only among those of you who are teachers, but among all others as well, for the former will be strengthened in their efforts, if they have behind them the good will of the great body of chemists.

In what I shall say I may seem to take issue in one or two matters with the views recently expressed by a distinguished foreign teacher and investigator, but the difference, I surmise, is more on the surface than fundamental.

Many inquiries addressed to the participants in one series of analyses elicited the information that few knew nothing definite about the quality of the water they were using, though examination showed it to be bad in a few instances and on the border line in others. Still less was known as to the quality of the reagents, except that they came from reputable firms. One admitted that a flaky sediment showed in his ammonia bottle, but he used only the clear liquid above. If the sediment represented silica from the bottle, as may well have been, what had become of the other constituents of the attacked glass unless they were in solution?

*A paper read at the Philadelphia meeting of the American Chemical Society, and printed in the "Journal" of the Society for March.

†Washington, D. C.

Now why were these things possible unless because it had never been sufficiently impressed upon them in their student days that without proper tools to work with, among which water and reagents are first to be considered, good work is impossible? You doubtless do not fail rightly to tell them that absolute accuracy is unattainable in analysis, but do you make it plain that approximation is possible and that it will be the closer the greater the care bestowed upon the tools and at every step of the analysis itself? Is a student ever required to find out by actual test how good his water is and both the kind and amount of its contamination, if such there be? Is it customary to instruct him in the testing of his reagents and as to the character of the contaminations to be looked for in all of the more important ones, or is he allowed to go forth with the impression that the label C. P., while not a flawless title, is a sufficient guarantee for all the

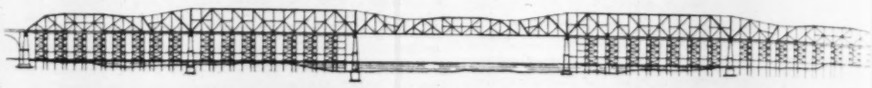


FIG. 8A. ELEVATION OF FALSEWORKS OF CANTILEVER BRIDGE AT THEBES, ILL.

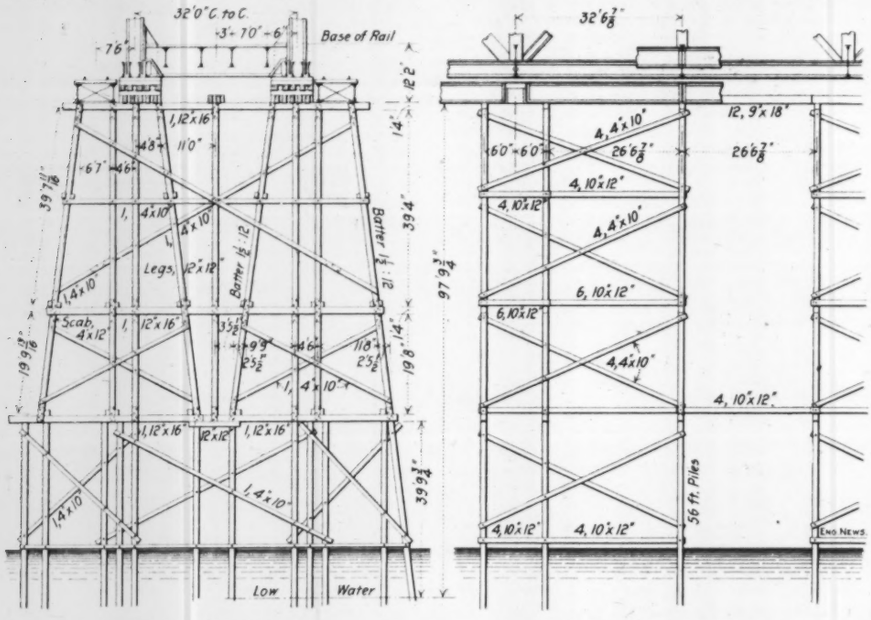


FIG. 8. DETAILS OF FALSEWORK.

demands of technical analysis? Is he, in fact, ever cautioned to find out, by actual test, the errors with which his work may be affected, due to imperfections in his tools of the kind just mentioned. And that without such knowledge and the ability to make correction for the defects, or the courage to fight for better materials with which to do, he will occupy a false position with respect to himself, his employers and the community at large?

My experience of the past few years has convinced me that in these respects, at least, much is neglected that should not be neglected in the curricula of our colleges. It seems to me that if instruction in such fundamental essentials is not thoroughly drilled into the budding chemist, so that it becomes for him as much a matter of course afterwards to look to the quality of his tools as it is to weigh out his sample before analyzing it, he has received a scant equivalent for his years of study, and that he has good grounds of complaint against his alma mater if he comes to grief by reason of her neglect.

Is the student's work ever checked against material of which the exact composition is known? I do not refer here to such things as simple salts, but to more complex bodies like limestone, cement, zinc ore or slag, in which many separations have to be made and all constituents should be determined. Is the student in such analyses religiously required to test the purity of his precipitates and the completeness of his precipitations by a careful examination of the filtrates? And is he taught that a satisfactory summation does not imply correct separations? Or that closely agreeing duplicates are not proof of good work?

Only by such exercises can the young worker gain any knowledge as to his own power to do good work, and acquire that proper confidence in himself which is so essential.

Just here the committee which I represent may be, perhaps, of some assistance in preparing for distribution, either through its own agency or that of the Bureau of Standards when that institution shall be in position to lend permanent aid, large samples of various materials of which the exact composition will be ascertained. These will then be supplied on demand to all who may wish to check their own, or their students' or employees' work. It is the earnest hope of the committee that the invitation which it contemplates issuing to collegiate instructors will be met in a cordially receptive spirit, namely, to analyze or cause to be analyzed, by their most advanced students, a limestone of known composition which the committee will undertake to distribute. In this way can be acquired in a short time valuable information as to their own abilities or the skill of the young men they are sending into the chemical arena. Incidentally, the merits of the methods they teach will be tested.

Another point brought out by the recent series of zinc-ore analyses is the failure of many to exercise discrimination in the choice of methods for different classes of ore, they being seemingly ignorant of the fact that a method of solution employed in one case may be ineffective in another, or that the presence of so-called interfering elements may forbid the use of a method otherwise unobjectionable. Some seem to have made no effort to ascertain if such interfering elements were present. The committee on zinc-ore analysis, whose report is in small part published in this Journal, 26, 1648, voices ideas similar to the above in the following words: "Instead of teaching analytical chemistry most of the schools teach what one instructor has well called 'cook-book methods,' that is, schemes of analysis which give the student no ideas of the principles of analytical methods, but make him think that the analysis of one kind of ore is something essentially different from the analysis of any other. One-fifth of all the analysts represented show the effects of this kind of teaching and either use methods which contain no means of separating manganese and copper on ores that contain large amounts of these interfering elements or use methods that will not decompose the ores at the start."

From what I am told regarding the ratio of instructors to laboratory students, there is in many of our institutions woful lack of supervision of the work of each individual student. I have little patience with the principle which in effect puts a book on analysis before a beginner and tells him to find his own way through the various analyses, with such help as he may get from his fellows and an occasional hasty call from an assistant. Circumstances, no doubt, often compel the following of this plan, but its adoption is, to my mind, little less than a crime against the learner. I believe it is held by some that the really good student will come success through this mill and the others fall by the way, but much better off the good student would be, for more a tion at critical periods seem to be left out of consider Facts seem to speak against the success of this t There are hundreds of little tricks of manipulation the student cannot learn for himself and which he be taught by a conscientious assistant, having little but devote his whole time to a limited number of wo This brings me to the remark that no laboratory in tor should be required or allowed to do outside either for his superiors or himself, so as to encro any way upon the time that should be given to under his supervision. This would necessitate decided increase in the corps of instructors, so as deprive them of opportunity for research work. O fundamentals have been mastered, the worker, started, may well be left more to his own resourc even then he should receive frequent visits for the of guarding against relapse from right ways, for needed additional information, and answering the queries that are pretty sure to occur to a good st It is far better that the student should learn to do paratively few things thoroughly, mastering the and wherefores of every step, than a great many ficially and without acquisition of the underlying ciples. It is only the one thus thoroughly grounded who is in a position to use or devise short cuts without great danger.

Doubtless many works chemists are compelled to labor under conditions which preclude the highest class of work. Dust envelops them and makes cleanliness impossible and a high grade of water and reagents useless, or such is the haste called for in order that the results shall be of use to regulate the daily running of the furnace or mill, that the highest or even a high standard is unattainable. Let it be admitted that even these crude results suffice to regulate and control the smelter charges, or the cement mixture and its finished product, yet no chemist who has to work under such disadvantages should permit himself to enter into analytical competition with those better situated in these respects without stating plainly the disadvantages to which he is subjected. Especially should he never undertake commercial analyses for pay, with which goes the implied understanding that the purchaser is to receive full value for his money. Moreover, even he who is so unfortunate as to be handicapped in the ways mentioned will be able to do better work than otherwise, if the foundations of his knowledge have been solidly laid.

Often, no doubt, the ignorance or indifference of the owner of the works is responsible for the distressful conditions under which the chemist labors. The young chemist is naturally disinclined to risk his place by a too determined opposition to existing conditions or by insistent demands for their betterment. The situation is unfortunate, and it is difficult to see how it is to be remedied except by the gradual growth of appreciation among employers that chemistry is a handmaiden worthy of far better treatment than she now receives, that she needs careful housing and feeding in order that she may give good work at all times. Possibly employers may, to some extent, be aided in reaching this enlightened

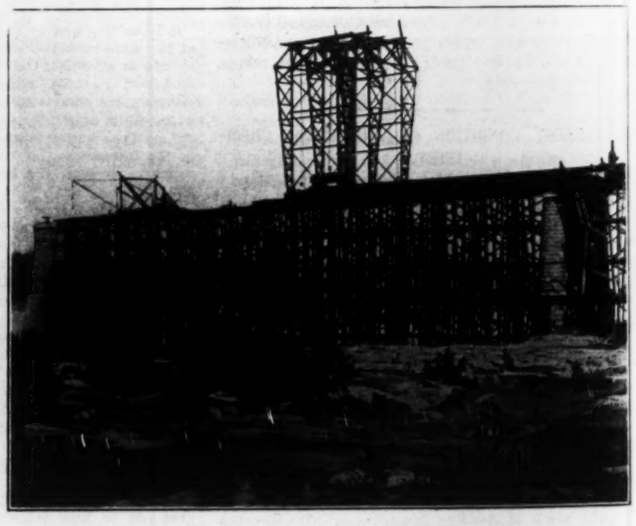


FIG. 9. TRAVELER FOR ERECTING FIXED AND SHORE SPANS.

e by the refusal of professors of chemistry to recom- students to accept positions where the conditions known to be needlessly incompatible with satisfactory k.

Another condition in which I hope to live to see the ning of a radical change, is that of the quality of ents accepted and used unhesitatingly for most kinds

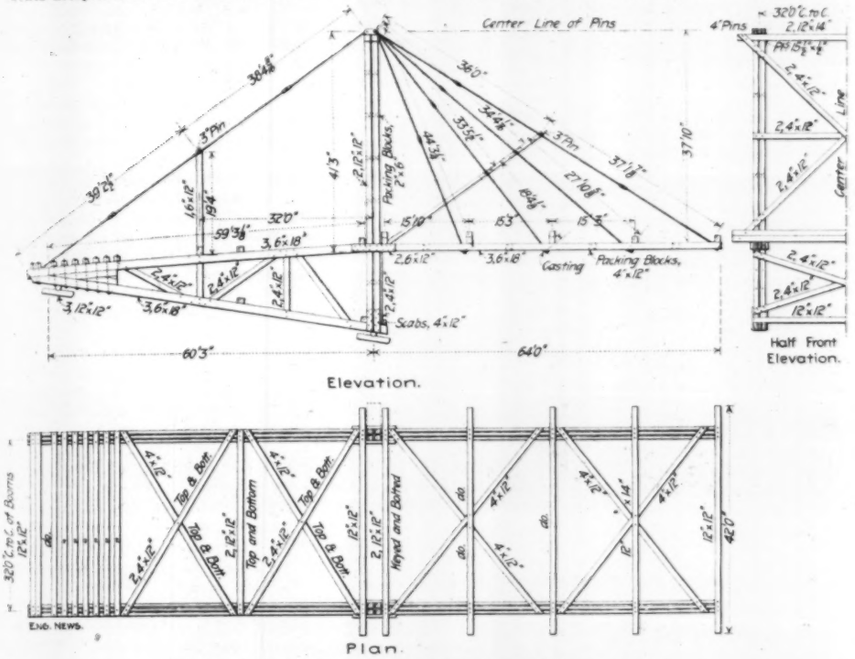


FIG. 10. TRAVELER FOR ERECTING CHANNEL SPAN.

of work, not merely technical in character. How often have I heard it said: Oh! this is good enough for technical work! Possibly it is for one kind, but it is sure not to be for some other. This necessitates either a multiplicity of grades of certain reagents or the need for special purification by the chemist, or, a commonly accepted alternative, incorrect results.

Let me emphasize this point by an illustration. The solubility of gold in nitrous acid has long been a disputed matter, yet an important one in assaying. Not long since a chemist sought to settle the question, and prepared nitrous acid from potassium nitrate. With this he effected solution of from 1% up to nearly 50% of the gold acted on, according to the temperature employed. No one seems ever before to have observed any such marked effect, and the experiments were repeated by Dr. E. T. Allen in the laboratory of the Geological Survey, care being taken to prepare the nitrous acid from a nitrate free from chloride. The result was that, despite the utmost care, no positive solvent effect on gold could be observed. The inference is that the nitrate employed by the author of the original statement contained chloride, which was almost certainly the case, if it was not an article of unusually high grade, such as is not likely to be found in an assay laboratory. To what extent, if at all, the author's instructors may be indirectly responsible for the harm that has been done by the dissemination of such erroneous information, it is, of course, impossible to tell. The harm has been done, however, and undoubtedly by reason of the employment of a low-grade reagent where one of exceptional quality was demanded.

Unfortunately, the refutation which will shortly appear cannot entirely undo the mischief already spread.

Why cannot instructors come to a clear understanding that good work requires good tools and that this is quite as true in the rush of a works laboratory, unless conditions utterly debar cleanliness, as it is anywhere else? Why should they, unintentionally of course, lower in the minds of their young men the dignity of the work these latter have set out to do? Why not from now on, one and all, resolve to pursue a different course? By so doing you will render comparatively easy the task of the Committee on Purity of Reagents. Even as it is, one firm of chemical manufacturers in this country has announced to me its entire readiness to do its best to furnish reagents of the quality the committee may eventually decide to call for, and, unofficially, I have been told that a large importing firm will provide the reagents when the committee's specifications are known. It only needs concerted and persistent refusal on the part of the heads of educational laboratories to accept any but really good reagents to bring about before long a most radical change in the present situation regarding these most important tools of the chemist.

It is doubtless a fact that the ever-widening field of chemical application and the overwhelming multiplication of analytical methods make it more and more difficult to cover the whole field in any but a superficial manner in the time which it seems possible to give to chemical study, and hence render extremely obscure the solution by our chemical educators of the problems presented for their consideration. The difficulty is enhanced by the following condition: Chemists in charge of large industrial laboratories sometimes prefer young men not too well informed as to a variety of methods, but would have them come unfettered by preconceived notions and so ready to adopt, without objection, the methods in vogue in the particular laboratory. While a knowledge of many methods may be rather deprecated by their chiefs, a thorough grounding in general chemistry and the theory of analysis is, however, greatly desired by them in their young assistants.

On the other hand, the young man who is suddenly called upon to fill the sole chemical position in a mill or smelter, and upon whose work the successful running of the establishment may depend, would be sadly, if not hopelessly, handicapped were he equipped only on the theoretical side of his profession. How to avoid both horns of the dilemma and yet graduate our young chemists properly equipped and unimpaired in efficiency for their life tasks is a problem that is taxing and will long tax to the utmost the best efforts of our foremost chemical educators.

While I have thus endeavored to point out wherein our colleges may be more or less remiss, it is not for a moment to be asserted that they are altogether responsible for the present situation. There are other factors concerned, and among them is uncertainty as to the value or adaptability of many methods. Herein, the National Bureau of Standards, if its effective cooperation can be secured by a moderate grant from Congress, may become of great value in the testing and comparison of methods by men of experience, who are not so pressed for time as to be unable to check their results in manifold ways. The work of advanced students in the comparative investigation of methods is often excellent, though sometimes of more value as training to the student himself than to the public at large, but the average value of work of this kind must be enhanced by having it done by men of ripe experience, whose whole time can be devoted to it.

Let us then, for one thing, continue and extend the work begun over a decade since by the iron and steel chemists and now carried out by those engaged in the agricultural industries and in the examination of food products. It has been shown that the shoe pinches not only one or two toes, but several, and the remedy must be sought for and applied speedily before the injury becomes too great or incurable. We must not flinch at the prospect before us, but take up the task with stout hearts and a determination to get at the roots of the trouble that afflicts us, for there is more than one root, as I have already intimated, and then to apply the appropriate remedies.

It is most important that the educators of future generations of chemists ponder these matters and endeavor to devise ways for improvement, if not by concerted action, then by the efforts of single colleges.

ENGINEERING APPRENTICES AT THE WORKS OF THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO.*

By H. Eloesser.

Of the numerous apprenticeship courses which are to be found with the Westinghouse Electric & Manufacturing Co. that one of the greatest interest to the college student is the course given to the engineering apprentice. The requirement for entering upon this course is a degree from an engineering college. Before thinking of entering upon this course the student should know that he must sign a contract to remain apprenticed to the company for a period of two years. The apprentice works 54 hours per week; 9¾ hours on the first five working days of the week and 5¼ hours on Saturdays. At 16 cts. per hour, the rate of pay for the first year, this amounts to about $36 per month, taking into account holidays and lost time; at 18 cts. per hour, the rate for the second year, to about $40 per month. Room rent varies from $6 per month apiece with two in a room, to $15 for a single room. The price of board varies from $15 to $22 per month.

The lack of social life in Pittsburg is undoubtedly one of the greatest drawbacks to this course. It seems strange indeed that any city so close to New York should have so little of its life and bustle. The immense factories centered in this district have resulted in forming a population in which the laboring class forms a very large percen-

*From a paper in the "California Journal of Technology."

FIG. 11. GENERAL VIEW OF CANTILEVER BRIDGE ACROSS THE MISSISSIPPI RIVER AT THEBES, ILL.

tage. The result is shown in the almost total absence of proper amusements. The stranger in Pittsburg is almost buried unless he avails himself of every possible letter of introduction or of other means of making acquaintances.

The works are situated about fifteen miles from the city; and almost all the apprentices make their homes in Wilkinsburg, a suburban town about half way between Pittsburg and the company's shops. This is a desirable location, being comparatively free from the smoke and grime

FIG. 12. VIEW OF THEBES BRIDGE, SHOWING CONCRETE ARCH APPROACH ON MISSOURI SIDE.

of the factories. The Electric Club is situated here and forms a nucleus for people from all parts of the world. During the summer its tennis courts are much in demand, and in winter frequent lectures and entertainments help to enliven the quiet of its reading room. From Wilkinsburg to the works in East Pittsburg is a ride of twenty minutes by train. Work commences at 7 a. m.

The apprentice is placed in different departments of the works, and remains in each of them for a given length of time according to the importance of that department. An apprentice placed in Section B, in which are built the large machines up to several thousand kilowatts capacity, would remain a month in the department of "assembling," two months in the department of "winding and connecting," and one month in the department of "finishing." In Section E, in which coils and insulation only are made, he would spend two weeks in winding, one week in armature coil assembling, one in field coil assembling, one in the mica department, etc. On the test floor the apprentice usually remains from six to fourteen months.

The course is not a cut and dried one, and scarcely any two apprentices go through the same sections. Many of the apprentices go into the offices for from two to six months. The work there is not manual labor: the working hours are shorter than in the shops and the work more pleasant; but on the other hand, is in some cases less valuable.

The company does everything possible to help the apprentice to learn. He is given the run of the shops during noon hours and frequently finds spare time to examine some new piece of apparatus during the day. Pamphlets and explanatory circulars and publications are furnished him on request. Question boxes are placed in convenient places where he may drop a note asking the purpose of some new piece of machinery which he does not understand. In short, the apprentice is given every chance to learn all he can. The work, however, that he does is largely dependent upon himself. He can go into a section and be set to help a man, and he may sit and watch and do little work, or he may do a great deal.

The workmen are fond of criticizing the students and their criticisms are often very pertinent. One man with whom I worked, speaking of the apprentice before myself said, "He used to stare at the ceiling all day; I'll bet he knew every rafter in the aisle before he left, but he couldn't tie a knot in a string." Another said concerning an apprentice who was wearing a white collar, "That fellow, I would not give him any work. I'm afraid he would spoil his clothes." I saw one apprentice helping a man to solder the ends of bars on an induction motor. Before long he left and returned with another iron and started to work on the other side of the machine. The workman objected that the boss might not like it; but soon got used to the situation and before long the apprentice was doing all of the best work that was given to apprentices to do. All this goes to show that the good is in the course and that the company gives the apprentices their opportunity, but does not force them to improve it.

As for the results of the course, the company makes no promises to take a man on after he has been with them the two years. In very many cases it does take them on. In this case they always begin with a low salary, perhaps $50 per month.

MORE ABOUT SUBMARINE TELESCOPES.

By A. McL. Hawks.*

In Engineering News of May 19, 1898, p. 323, there was published a short description by the writer of a "water spy glass" or submarine telescope, which he had used in some river work where the water was very roily. In connection therewith I outlined some improvements which might be made and gave an idea of what results might be expected.

Within the last few months three devices have been brought to my attention by men claiming to have invented them, who desired me to indorse them as "good things" so they might sell stock or an interest in them. The exploitation of the submarine telescope of the Italian, M. Pino, in the magazines, also shows that considerable interest is, at present, being taken in submarine investigation and exploitation.

Having spent considerable time and money along this line, it seems to me desirable that whatever results I have obtained should be given to the profession at large for whatever they may be worth.

The instrument with which I worked was made of an 8 ft. length of 4-in. wood pipe having a double convex lens, 5 ins. in diameter, placed in the bell end; and an ordinary marine glass of 1-in. aperture, with the middle lenses removed, placed in the taper end. The inside of the tube was painted with three coats of dull black paint and

*Consulting Engineer, 402 Berlin Building, Tacoma, Washington.

the larger glass was securely puttied in so [illegible] make it possible to use the telescope when [illegible] submerged and yet have no water in the tu[illegible] could find no data to guide me in the constru[illegible] of this instrument and had largely to fe[illegible] way with some results which were quite a[illegible] ishing.

One of the most remarkable results was [illegible] upon submerging the telescope, the objec[illegible] took the form of a plano-convex lens as s[illegible] the face of it touched the water; but whe[illegible] was thrown down the tube it immediate[illegible] sumed its old form of double convexity a[illegible] jects viewed during the process seemed [illegible] to turn somersaults. The marine waters [illegible] coast are usually remarkably clear so th[illegible] the naked eye an ordinary 8-in. dinner pla[illegible] be readily discerned in 10 or 12 ft. of wat[illegible] the aid of this telescope, when its lower e[illegible] submerged, three or four feet, this same [illegible] plate could be seen in 25 or 30 ft. of wat[illegible] seen so clearly that the maker's trademark [illegible] 1 in. in diameter, could be plainly seen and [illegible] read.

Another of the oddities connected with th[illegible] experiment was that in the next two or thre[illegible] beyond where the object could be seen so distinctly, it would entirely disappear. This seems to be true of looking through water at all depths, so far as I have investigated, for the range of vision (which may be taken roughly as a circle 15 ft. in diameter) is the same when looking out through a diver's helmet at a foot below the surface as it is in 105 ft. of water; and objects seem to be about as clear within this visual range in the greater depth as in the lesser. In this case also the disappearance is very sudden. Fishes and other moving objects appear suddenly from nowhere in particular and seem to jump into view; or if traveling away from one, are in plain sight until they just as suddenly vanish entirely.

There was one feature concerning diving which all the "old line" divers said would militate against my success, i. e., the necessity of wearing glasses. They predicted all sorts of trouble for me, such as fogging, dimming, etc., so that I scarcely expected to see at all; but as I am "out of focus" to objects 10 ft. distant, without glasses, I was compelled to undertake it; with the result that there was no difference which I could observe between submarine work and work in the "ocean of air" in which we live. Therefore let all spectacled men take courage if they wish to investigate the larger world of living things below the ocean surface.

In conclusion I beg to say that which I had in mind in my opening paragraphs, and that is that no patent was taken out by me on the water spy-glass; and I do not believe any body can get a patent for more than the minor details of their invention in connection with such telescopes.

FIG. 13. PORTAL VIEW OF THEBES BRIDGE AT ILLINOIS END.

THE SEVENTH INTERNATIONAL RAILWAY CONGRESS.

The seventh meeting of the International Railway Congress may be said to have begun at New York City on Monday, May 1. Most of the foreign delegates to the Congress arrived at New York on transatlantic steamships, and a party of about 200 assembled at the Transportation Club on Monday morning preparatory to a day's excursion about New York City. They were welcomed here by a local committee, headed by Mr. W. G. Besler, Vice-President of the Central R. R. of New Jersey, and the day was spent in inspecting the railway terminals in New York and vicinity, the Rapid Transit Subway, the new Pennsylvania R. R. tunnel works and other features of engineering interest.

On Tuesday morning the delegates traveled via the Reading and Pennsylvania lines to Philadelphia, where they were met by the Philadelphia local committee, headed by Mr. John H. Converse of the Baldwin Locomotive Works, to which great industrial establishment the visitors were directly taken. After an hour spent in the inspection of the plant, a handsome luncheon was served in the electrical storage room which had been cleared for the occasion. Brief speech making followed and then the visitors entered carriages in which they were driven about the city to the chief points of interest for two hours, finally arriving at the railway station where special express trains for Washington were taken at 3:30 p. m.

At Washington the general headquarters of the Congress are at the spacious New Willard Hotel, and here most of the party were located.

OPENING OF THE RAILWAY APPLIANCE EXHIBITION.

One of the most, if not indeed the most important feature of the Congress is the exhibition of American railway appliances which has been created by the manufacturers of American railway supplies. As recorded in this journal some months ago, an organization was formed of the leading manufacturers of railway supplies, and with the hearty cooperation and support of the American Railway Association an appeal was made to Congress for permission to use the "White Lot," a part of the Washington Monument grounds, as a site for an exhibit of American railway appliances.

The necessary permission was granted, but under restriction as to time of occupancy that called for the exertion of genuine American hustle in a superlative degree in order to complete the exhibition in time for the opening of the Congress. The task was accomplished, however, and the exhibition was formally opened at noon on Wednesday, May 3. The exercises were attended by a very distinguished company, including besides the official delegates a large number of the heads of government departments and members of the diplomatic corps.

Mr. Geo. A. Post, Chairman of the Committee in Charge of the Exhibition, called the assemblage to order and delivered a noteworthy address, from which we quote the following:

The American Railway Appliance Exhibition is an accomplished fact. Its portals are open, its grand display of the products of more than 300 factories is ready for inspection.

The plot of parkage where on this exhibition stands is the property of the government of the United States. Under the provisions of the congressional joint resolution our occupancy of the grounds was permissible only from March 20 to May 25. At sunrise on the morning of March 20 this ground was absolutely barren of any semblance of a building, nor was there a single stick of timber hereon. All of these buildings and all of the enormous machines and the infinite variety of railway appliances now here have been erected and installed in the brief period of 43 days.

The actual number of corporations, firms or individuals enrolled as members of the American Railway Appliance Exhibition up to this moment is 370.

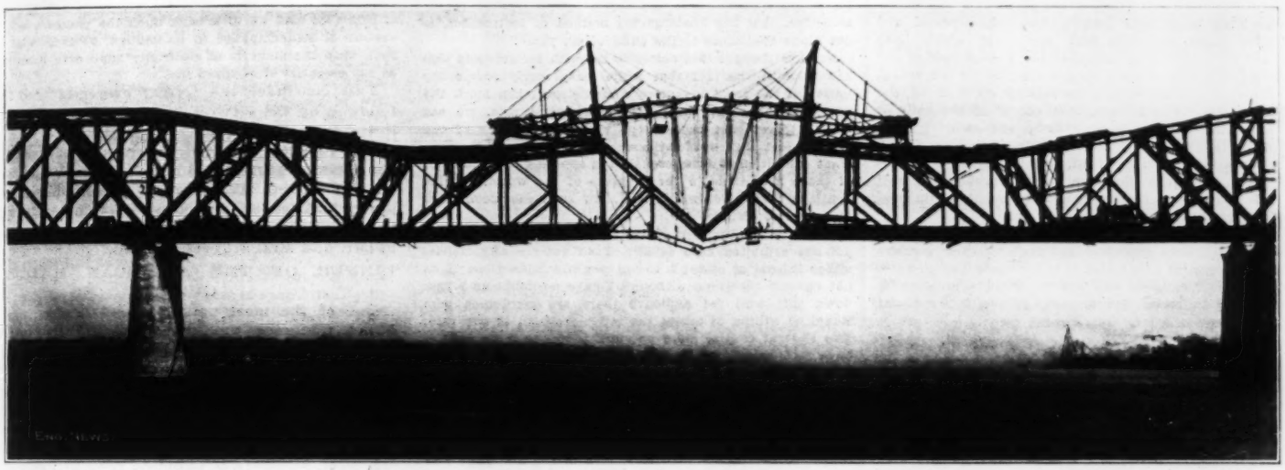


FIG. 14. VIEW OF TRAVELERS AT WORK ON CLOSING PANELS OF CENTER SPAN OF THEBES BRIDGE.

The season of this exhibition will expire at midnight, May 13. Between that time and the morning of May 26 the work of demolition and removal of everything that now rises above the surface of the ground must be accomplished and the ground restored as it was before this evanescent mechanical metropolis reared its myriad marvels thereon. Not in a spirit of boasting, but as a statement of fact worthy of record, it is asserted that never before was such a comprehensive assembly of exhibits made, nor such an expenditure of money incurred, for an exhibition to continue for so short a time as is here witnessed.

We present to you, gentlemen, who control the railways of the world, for your inspection, our best thought upon the problems that confront you. To meet your necessities is our hope of reward. To accomplish economy in your operations our constant study. To keep pace with ever changing conditions requires our unceasing vigilance. To merit your favor is the goal of our ambition.

A grand division of the army of progress is here encamped. It seeks not slaughter. It marches not to the strains of martial music, nor with glistening bayonets and death dealing cannon. The visage of its soldiers is not grim with hate. Its fields of contest are not reeking with blood. Its battles are fought to subdue difficulties, not men. It plans revolutions not in government but in methods. Economy is its watchword. Its animating purpose is to save life, property and time. It is on dress parade here to-day. Before this brilliant assemblage it stands, erect and expectant, eyes front, awaiting—orders.

Mr. Post then introduced Hon. H. B. T. Macfarland, President of the Board of Commissioners of the District of Columbia. We quote the following paragraphs from his address:

The National Capital, founded and planned by George Washington, greets you most heartily in the opening of this exhibition at the very foot of his unique monument. It is most fitting that you should meet here. George Washington was the pioneer among our statesmen in promoting long-distance transportation, although he knew only roads and canals, passing away before he saw, great seer as he was, the expansion of the nation and the contraction of time and space which the new facilities have brought about. But for railroad and telegraph the National Capital would not have remained here, but would have gone far west with the advancing march of our population, if indeed, as may well be doubted, the States could have remained united without the railroad and the telegraph.

The first public American railroad, the Baltimore & Ohio, early came to Washington. Its first rail was laid on the 4th of July, 1828, by our neighbor, Charles Carroll, of Carrollton, then the only surviving signer of the Declaration of Independence. The first telegraph line ran from Washington to Baltimore. The first message was sent from the capitol, and the first long distance telephone line reached to Washington. The great-grandson of Charles Carroll, of Carrollton, the daughters of Joseph Henry, the son of Samuel F. B. Morse, and Alexander Graham Bell himself, we claim as now residents of Washington.

The labors of Hercules, the wealth of Croesus, are surpassed by the marvelous achievements in transportation and communication in the short period of one lifetime. In the three-quarters of a century since the Washington Monument was first projected, a revolution has occurred in the industrial as in the scientific sphere unparalleled in the former history of the world; inventors, pioneers, mighty builders and executives have transformed our methods of transporting and communicating. Great with the arduous greatness of things done, they have often wrought roughly, but they have wonderfully increased the national wealth, comfort and convenience, and decreased prices as well as distances. It is now axiomatic that the material prosperity of a country is in the ratio of its railways and associated facilities. In the presence of our distinguished guests from abroad, delegates to the International Railway Congress, which we hope to see return at frequent intervals to hold its session here, we Americans do well to express our gratitude to the great men, living and dead, who have done so much in these fields for our new country.

Mr. Post then presented to the audience as the permanent chairman, Mr. Geo. Westinghouse, introducing him as follows:

Upon this day, big with importance to American manufacturers of railway appliances, as they meet to greet the railway pioneers from all over the world, there is one man who by reason of his great achievements, commercial courage, scientific attainments and international fame, stands forth as naturally the choice for the post of presiding officer over this distinguished gathering. His name needs neither prefix or affix to denote his eminence, it is my prized privilege to present George Westinghouse.

We print Mr. Westinghouse's remarks, nearly in full:

It is difficult for me to adequately express my appreciation of the honor of being asked to preside upon this important occasion by those who have brought about this exhibition of railway appliances in order that our distinguished guests, during their sojourn in Washington, may have the opportunity to study at their convenience the result of the efforts of many active minds engaged in the development of appliances, methods and machinery, having for their object the better, safer and more comfortable operation of railways.

It is especially gratifying to feel that this exhibition has been desired by the representatives of the great railways and has had the encouragement of the Congress and of the President and members of his cabinet, who are to participate in these ceremonies.

To refer in detail only to the most important of the requirements to insure the safe movement of railway trains at high speeds would be a task, but to those who have made a study of the never ending subject there stands out the fact that only by the concentration of the best efforts of our best men have our great railway systems reached their present state of perfection, and the very important fact that the rank and file of operatives perform their duties under such onerous conditions, night and day, and

in all kinds of weather, so well that the traveling public have ceased to realize and appreciate their almost unerring accuracy of thought and action.

A new era of railway operations has dawned, with its many new problems. I refer to the growing use of electricity for the movement of trains. There have already been such demonstrations of the benefits to be derived from the substitution of the electric motor for the steam locomotive that it requires no great prophet to predict the extensive growth of electric traction upon the great railways of the world and the eventual replacement of the steam locomotive. Fortunately the time element, which is such a controller of events, and the financial problems involved, will insure gradual development and extension of the use of electricity.

With these changes have come vastly different engineering problems and new sources of danger, which should, and will, command and receive that attention which is essential to the surmounting of every difficulty as it arises.

The efforts of railway managers have been supplemented in a most extraordinary manner by a great body of engineers, inventors and other managers of men and of affairs. They have very largely designed, invented and perfected these machines and appliances which have wrought such wonderful strides in the development of our railways. They have built up great works for the manufacture of the material and machinery required by the railways, and without which the efforts of the railway managers, whose time is necessarily and rightfully engaged in the administration of their properties, would have borne less important fruit, and it may be appropriately said, therefore, that the railway problem is well divided into one of construction and one of administration and operation.

Representatives of that great class of constructors for whom I speak have organized and installed their exhibits upon this beautiful site, which it is my honor and pleasure to assist in opening to our guests, as an expression of their desire to make this meeting of the International Railway Congress a memorable event.

The remaining addresses were made by Secretary Morton, of the Navy Department, Secretary Taft, of the War Department, Hon. C. N. Lawrence, Deputy Chairman of the London & Northwestern Ry. Co., and Stuyvesant Fish, President of the American Railway Association and of the Illinois Central Ry. Co. We present a full abstract of the addresses made by each of these men, below.

SECRETARY MORTON.—When the microbe of civilization first enters the brain of a barbarian he begins to think of a better trail through the mountain or a better pathway over the plain, and as civilization advances, good roads and cheap transportation occupy the thoughts of the best minds of the world. The present conference of delegates from all over the world to discuss ways and means of bettering its transportation facilities only indicates the growth of civilization and demonstrates that there is reciprocity in the exchange of ideas concerning the best way to carry on railroading.

The story of transportation in this country is the history of American progress. It is no exaggeration to say that the prominent position that the United States occupies to-day in the world is chiefly on account of its low railroad rates, and it is not at all out of the way for me to say that if it were not for the American railway appliances, the cost of transportation in this country would be much higher than it is to-day. It has been estimated that where one dollar has been invested in railroads there has been an advance in agricultural property of ten dollars. The steel rail and the steam engine, with all the other railway appliances, have been pioneers in the development of the country. Many unknown sections, especially the great West, have been prospected, almost, by the locomotive. The story of American railroads reads like a fairy tale. There are men living to-day in the United States who are older than any railroad. The railroad business is, relatively speaking, in its infancy, and yet see what has been accomplished! In less than one generation of men there has been a most remarkable abridgment of distances. Lord Bacon truly said: "There are three things that make a nation great; fertile fields, busy workshops, and easy conveyance of men and goods from place to place." Lord Bacon was especially right so far as America was concerned, and you will all see the force of his remarks when you apply it to this country. To-day with great luxury and comfort at a cost less than three cents a mile, travelers accomplish in less than one hour what sixty years ago was more than a day's journey. In other words, you save 23 hours out of 24, and you do it by less than one-tenth of what you had to pay then.

The railroad freight rates of the United States are low. No other country has any such cheap carriage of goods. There are very few complaints of rates in this country because they are too high; rates are lower in the United States than anywhere in the world, and complaints of extortionate rates are the exception, not the rule. The fact that rates are lower here than anywhere else in the world, the fact that they will approximate 40% lower probably than anywhere else in the world, is something to be proud of. But this, coupled with the fact that with the lowest rates in existence the wages paid by the American railroads to their employes approximate at least 50% more than the wages paid to railroad employes in other countries, and considered further with the fact that the American railroads probably pay higher prices for materials than any other railroads in the world, only serves to emphasize the triumph in transportation which has been achieved in America. My observation has been that complaints to railroad men of unreasonable rates always receive prompt, and generally satisfactory, attention.

SECRETARY TAFT.—One thought that comes to me in looking about at this magnificent exhibition is not so much the great ability displayed in so short a time in its construction as the difficulty that must be presented to the railroad supply man and the ordinary inventor in bringing into the common human mind the advantages of his supplies and of his inventions. If it will pay a manufacturer to spend as much money as must be spent here in order to get through our heads what is necessary for the improvement of the world, how stupid the minds of men must be! It shows, after all, that the world is exceedingly conservative, that the object lesson method of instruction, that the kindergarten method of instruction, is not alone applicable to the child of six years.

Another thought that comes to me with reference to this exhibition is the fact that while we properly revere the names of the great inventors whose steps taken mark the epochs in the progress of the mechanical arts, we are apt to forget that those steps when taken were of the crudest, and that but for the small inventions and the constant exhibition of American skill in applying the principles of those inventions to the progress of the world, the inventions themselves would not show such enormous steps in behalf of civilization.

There are a number of railway appliances that I do not see exhibited here at all. I do not see any courts, either federal or state; I do not see any injunctions; I do not see any receivers—although I have no doubt as I look down this well fed audience there are gentlemen who would be willing to accept the latter position, at any rate. The Federal courts, more possibly than the State courts, have received a good deal of criticism for their intervention in railroad matters. They exerted the branch of their jurisdiction known as equity to preserve the continuity of railroad traffic in this country, and they did it crudely at first. It took years to build up a code of law under which bankrupt and failing railroads may be continued for the benefit of the public with least loss to the mortgage and other creditors. I do not mean to defend many injustices that have doubtless been inflicted on mortgage and other creditors of the railroads by reason of the fact that it was a new branch of jurisprudence; but I say, as you look back to that period when nearly all the railroads in the country had to be passed through a court of bankruptcy and read the history taken as a whole, you will find that they preserved the continuity of railway traffic. In other words, their jurisdiction is founded on the necessity of public interference to carry on what is a public obligation, namely, the carrying of passengers and freight.

I think the meeting here at the foot of Washington Monument is peculiarly appropriate. Washington was a great general, a great statesman, a great leader, but he was also a great engineer, and it is fitting that at the foot of the monument erected by a grateful United States to him, there should assemble a convention of men engaged in advancing the progress of the country and carrying it out along the lines laid down by that great engineer.

HON. C. N. LAWRENCE.—On behalf of the English delegates, and also on behalf of the London & Northwestern Ry., which I have the honor to represent, and which is so intimately associated with some of your great American interests, I beg to thank you for the invitation which you have accorded to us to take part in the present interesting ceremonies.

We in the old country have not been slow to recognize, and I do not believe the world at large has been slow to recognize, the great inventive genius of the American people. We have benefited by many of your inventions, and I for one am only too glad to see the reception which my friend, Mr. Westinghouse, has received, because I assure you that we hold that name and his works in the very highest honor in our country.

STUYVESANT FISH.—In the remarks that were made by the chairman of the Board of Commissioners of the District of Columbia, Mr. Macfarland, he referred to the fitness of this city and mentioned various reasons. He omitted to mention one, which is that near here, on this river, at Shepherdstown, there was first moved in America by steam anything that did move; it was a boat built by James Rumsey, and it did move four or five miles an hour against the current. That was in the year 1786. It was not a successful steamboat, but it was actually moved by steam.

Yesterday I looked over a record of the number of patents and the names of those to whom they were issued in the first 15 years, from Jan. 1, 1790, to Dec. 31, 1804. As nearly as I could count them, there were 640 patents granted. I then endeavored to ascertain what had been done in that direction in the last 15 years, a century precisely having passed, between Jan. 1, 1890, and the last day of December, 1904. There were issued from the office 379,030 patents.

In looking over that old list I saw the name of [illegible] again several times; I saw that of Oliver Evans, [illegible]ventor of the high pressure steam engine, the [illegible]acting steam engine, and, by the by, to Rumsey [illegible] it should be said that he was the first to form the [illegible] into the shape which it has ever after held, or [illegible] held, a cylindrical form. Down to that time they [illegible] been what we called tube boilers, which I rather [illegible] were of cubical form. Why they did not build [illegible] originally in the cylindrical form I do not know. [illegible] other names in that short list we find, of course, [illegible] Fulton and John Fitch, and another—which has [illegible] do with this occasion—Eli Whitney, for a cotton [illegible] our friends both in England and here owe him a [illegible] gratitude.

One thought has been before me in this con[illegible] which is that we are going through precisely such a [illegible] here to-day with regard to electricity as was gone [illegible] 100 years ago with regard to steam. As we now lo[illegible] at the names of Whitney and of Fulton, those wh[illegible] after us will look back upon the names of the in[illegible] of this day. As we look back upon the pioneers a[illegible] ventors of steam applied to locomotion, so they w[illegible] back upon the pioneers of electricity applied to loco[illegible] as one essential of civilized life.

This concluded the formal exercises and [illegible] followed by the serving of luncheon to the g[illegible] in the reception pavilion.

The remainder of the afternoon was spe[illegible] by the visitors partly in a tour about Washi[illegible] on the "Seeing Washington" automobiles; [illegible] partly in attendance upon a reception tende[illegible] to the delegates and the ladies accompanying [illegible] by Mr. and Mrs. Stuyvesant Fish.

DINNER OF THE AMERICAN RAILWAY GUILD.

One of the most notable social events of the entire Congress was the dinner given by the American Railway Guild in the banquet room of the Raleigh on Wednesday evening.

The American Railway Guild is a social organization, made up of representatives of all departments of the railway service. Membership in the Guild is limited to railway officers who have served on some of the standing committees of the American Railway Association. To those who are familiar with the work which has been accomplished by that Association's committees for the advancement of railway practice, during the past dozen years or more, especially, it is needless to say, that membership in the Guild is a notable honor.

The present officers of the Guild are: Theodore N. Ely, Master; Edward C. Carter, Warden, and J. E. Fairbanks, Clerk. The Guild was formed ten years ago and its past masters have been Messrs. C. D. Hammond, C. W. Bradley, A. W. Sullivan, Geo. B. Leighton, Thos. Tait, Geo. W. Stevens, T. E. Clarke, and W. F. Allen.

The dinner of Wednesday evening was given by the Guild in honor of the Permanent Commission of the International Railway Congress. About 200 were in attendance at the dinner; and among the guests present, besides the members of the Permanent Commission, were Vice-President Fairbanks, Secretaries Taft, Morton, Cortelyou and Shaw, Chief Justice Fuller of the Supreme Court, Martin A. Knapp of the Interstate Commerce Commission, Chas. D. Walcott of the Geological Survey, Jas. R. Garfield of the Bureau of Corporations, and Senator Henry G. Davis, Hon. Stephen B. Elkins, Hon. Wm. P. Hepburn, Hon. F. B. Loomis, and Gifford Pinchot. Among the well known railway officials besides the members of the Guild present were Messrs. A. J. Cassatt, Geo. F. Baer, Joseph Crawford, Sir Geo. Gibb, Geo. J. Gould, John P. Green, E. H. Harriman, Jas. J. Hill, Marvin Hughitt, M. E. Ingalls, Oscar G. Murray, W. H. Newman, Samuel Rea, Sir Thos. Shaughnessy, E. B. Thomas, M. H. Truesdale, Cornelius Vanderbilt, Sir Wm. Van Horne, W. Seward Webb, Geo. Westinghouse, and Col. H. A. Yorke of the British Board of Trade.

At the conclusion of the dinner the Master of the Guild, Mr. Theo. N. Ely, gave to those present a brief account of the Guild's history, and continued with some notable remarks regarding the problems faced by railway officials of the present day, which we quote as follows:

I have noticed with interest and great satisfaction the desire to "get together" which has developed so strongly during the twenty years in which I have been in touch with the affairs of the International Railway Congress

is, since its organization in 1885. The attitude of road officials one to another has changed remarkably. s have found through greater depth of vision, through e receptive minds, through seeking for the best ctices in the railroad world, that their own manage- t has been improved, and much better results ob- ed. In some countries the work of development may pushed more vigorously than in others, but every one found in another country something better than it has f. An essential requisite—to use a phrase that has me technical—is that there should be an easy and ral channel for the interchange of experiences, and has been provided through the medium of the Bul- s of the International Railway Congress. To this gress we should give our hearty support, and we uld assist in every way those who are in direct charge the affairs.

Probably in no profession is there demanded a more di- e knowledge of the activities of the world than that ch must be possessed by the railroad manager. As a ief executive he must be so thoroughly informed that can prophesy to a nicety far ahead, and be prepared to et every possible emergency in trade or financial con- itions. As a traffic manager he must canvass the mar- ets of the world, and be able to decide at a moment's otice how the transportation of his road can be disposed of to the best advantage, and with due respect to its ob- igations to the public. As a manager he must be well trained in not only the technical operation of his road, but he must, as well, familiarize himself with the changes in methods and facilities that are taking place in the indus- tries within his territory, and must know what influences such changes will have upon the character and volume of their output; and last, but not least, he must be in touch with and have critical knowledge of labor conditions in every department of the service, and a general knowledge of such conditions elsewhere.

The problems confronting the railroads are so many and varied that they cannot be touched upon even lightly at this time and place; but I am so strongly impressed with the importance of one general feature, that I feel impelled to ask your attention for one moment to its con- sideration.

We have reached a period in railroad development when we find it difficult to make material reductions in the cost of transportation; indeed, there are conditions present to-day that indicate a possible increase in cost. If I am right, it is the great question to be considered by those whose duty it is to procure a due measure of revenue for the railroads. Any student of the technical aspect of transportation cannot have failed to observe that, by force of circumstances, the factors that have contributed in the greatest degree to the reductions in cost have been rep- resented by the operations of the motive power depart- ment, and that the hope of further important reductions must still rest with that department. It is because of my long watching of motive power operations, as carried on in this country, that I am constrained to say that where modern equipment has been introduced and the most ad- vanced practices established, the margin for further re- duction in cost is very narrow and the balance may be easily thrown to either side.

When, some thirty years ago, the first step was taken in the introduction of larger units, reductions in cost were made by leaps and bounds, and have continued, but in a decreasing ratio, down to recent times.

On the other hand, the public demand for greater luxury in travel, and for quicker movement of traffic and im- proved facilities of every kind, contribute to an increasing ratio of cost. Whether this demand be just or unjust, need not be here considered. It is enough for us to know that it means an actual increase in cost, and that with our narrow margin for improvement, we cannot long continue to heed these demands, without in turn asking our patrons to share with us in meeting the increased cost of transportation.

A toast to the President of the United States was then drunk and response was made by the Secretary of the Navy, Hon. Paul Morton. In forcible clear-cut sentences he paid a high tribute to the courage, conscientiousness and marvelous ability of the President. Touching on the sub- ject of railway rates and their control by the Government, he declared that what the Presi- dent desired was square dealing, no favoritism, the abolition of rebates and of favors to private car lines, to owners of terminal railways and, in fact, any and everything by which the small ship- pers and small business man is handicapped in his competition with the large and powerful or- ganizations.

Secretary Morton's remarks were heartily ap- plauded. He was followed by President Baer of the Philadelphia & Reading R. R., who in a most eloquent address expressed his confidence and faith in the President's sincerity and desire to treat honorably and fairly the owners of railways as well as the public and the railway patrons. He emphatically opposed, however, control by the Government over railway rates; and with this sentiment his audience was evidently in entire sympathy.

Among the other speakers was Mr. Gifford Pin- chot of the Bureau of Forestry. Mr. Pinchot warned the railway managers present that they ought to foresee now the coming exhaustion of the world's timber supplies, and begin at once the work of timber culture on a large scale. It was idle to expect that relief from a threatening situa- tion would come through the introduction of sub- stitute for timber. Notwithstanding the enor- mous use of steel, concrete, etc., at the present day, the timber consumption is now larger than ever before, and not only is it larger because of the growth of population, but it is actually greater per capita. The great railway corpora- tions ought to promptly take the lead in the work of timber cultivation.

The next speakers were Secretary-General Weis- senbruch of the Congress, who spoke in English, and M. Ernest Gerard, representing President Du- bois of the Congress, who spoke in French. M. Gerard referred to the part played by Belgium in the organization of the Congress, and said that while Belgium has a population only one-twelfth that of the United States, it has an international trade one-third as large.

The last speaker was Mr. W. F. Allen, Secre- tary of the American Railway Association, who spoke in French, giving hearty greeting to the visitors from foreign lands. He remarked that a vision of the future was the organization of many railway guilds in all countries of the world united by a common purpose of work for the gen- eral welfare of mankind.

At the conclusion of the dinner the guests were taken in carriages to the Railway Appliance ex- hibit grounds where they witnessed a remarkable spectacular illustration of the flash of a time sig- nal all over the world.

THE TIME SIGNAL.

Upon the appliance exhibition grounds there has been erected a great map of the world, 22 ft. high and 40 ft. long. The location of over 200 of the principal cities and ports of the world is marked upon the map by incandescent lamps. As the hour of midnight on May 3 approached, a great audience gathered in front of this map and listened intently to the following explanation of the method of sending the time signal given by Rear-Admiral Chester as follows:

I take great pleasure in acceding to your request to say a few words in explanation of the series of telegraphic midnight time signals that we have agreed to send out from the naval observatory to-night, with the cordial ap- proval of the Hon. Paul Morton, secretary of the navy, in honor of this great International Railway Congress— signals which your indefatigable American secretary, Mr. W. F. Allen, has arranged to be flashed all over the world, if not actually around it and back again.

I am sorry to say, however, that in spite of every effort, and especially in spite of the powerful influence of Presi- dent Clowry of the Western Union Company and Vice- President and General Manager Ward of the Postal Tele- graph & Commercial companies, we do not expect to be able to complete the world circuit to-night, largely be- cause of the terrible war that is raging in the far East.

Mr. Allen, I feel, has good cause to be interested in this plan, inasmuch as he, more than any other one man, is entitled to the credit of the historic adoption of standard railway time in the United States, in 1883, and its sub- sequent adoption by almost every civilized nation.

To naval officers accurate time is essential in the navi- gation of the seas, even more so than it is to railroad men in the navigation of the land, and the naval observa- tory has sent out telegraphic time signals since 1865, and now drops 19 time balls in our principal seaports for the benefit of commerce. Incidentally, the same signals are utilized all over the country, and to no one are they more important and necessary than to the railroads that bind the country together with bands of steel. It is thus especially appropriate for the navy department to assist to-night in this one of the many accomplishments of that profession.

The electric lights that you see on the map are located at the positions of more than 200 of the principal cities of the world, most of which will receive, and all of which may receive, to-night's telegraphic signals. And you must remember, too, that these 200 lights are merely typical of many thousands of others that might properly be added along the 500,000 miles of wire and cable over which the signals will flash to-night. During these brief five min- utes we shall be in touch with the entire world, and it will, I am sure, appeal to your deepest emotions when you see this graphic representation of the nerves of civil- ization thrilling with the electric waves that unite nation to nation and annihilate space and time.

I need say only a word more regarding the method adopted in order to indicate the middle and end of each minute and to mark the final midnight signal, and some- thing in regard to the plan to be followed in lighting up the map.

The electric connections of the naval observatory clock are arranged to omit the twenty-ninth and the last five seconds of each minute, and finally the last 10 seconds of the last minute. Beginning at 11.55 p. m. the lights in North America and across the Pacific to Manila will be il- luminated automatically every second, representing the practically instantaneous delivery of the signals to that great region. The first flash after each short break marks the thirtieth second and the first after each five seconds break marks the sixtieth second. Finally, after the last and 10-second interval a long flash will mark the exact instant of midnight, and this long flash will spread quick- ly over the map, exactly as actual observation has shown that it passed along by thousands of operators, through hundreds of thousands of miles of wire, over continents and under oceans, and as it might come back to Wash- ington, to signal to all mankind the first meeting in the capital of the United States of the International Railway Congress.

The program was carried through exactly as indicated by Admiral Chester. The electric circuit connection with the Naval Observatory clock was closed by Secretary Morton, and at 11.55 p. m. the audience watched breathlessly the lamps on the map flashing the seconds in unison with the beats of the pendulum. Finally after ten seconds of darkness, at the exact moment of midnight, all the lamps on North America sud- denly flashed into brightness and remained lighted. A second later the light spread to the lamps all over Europe, and after a brief moment all the remaining lamps on the map were lit, in- cluding even such places as faraway Fashoda in the interior of Africa.

It was a most impressive exhibit of the wonder- ful results now possible in the instant transfer- ence of thought by the aid of electricity to the remotest corners of the globe.

FIRST GENERAL SESSION OF THE CONGRESS.

The delegates and guests of the International Railway Congress assembled for the first general session at 11 a. m. on Thursday, May 4, in the large ball-room of the new Willard Hotel. The Chair was occupied by the Vice-President of the United States, Hon. Chas. W. Fairbanks, who opened the session with an address which we print, nearly in full, as follows:

Gentlemen: The very pleasant duty rests upon me of extending to you a welcome to the seventh session of the International Railway Congress. I extend to you, each and all, a most cordial greeting. You who are accredited from foreign countries need no assurance from me that the American people welcome you with that genuine and generous hospitality with which you are ever pleased to receive Americans.

The railway is a mighty instrument of our modern civilization. It is essentially a creation of recent times. There are many men living who were born before the construction of the first railway either in England or in the United States. Its development has been one of the most marvelous evidences of human progress in recent times. It was created to meet an imperative demand; it was created locally to meet local conditions, but it has expanded until it binds together remote industrial centers; it has brought the capitals of the world nearer to- gether; it has crossed and recrossed continents; it has become an artery over which passes the commerce of the world; it has inextricably woven into the social, the commercial and the political affairs of millions and mil- lions of the human race. It has not only rapidly and vastly increased its mileage, but it has developed wondrously in the character of its construction and in the methods of its operation. Inventive genius, labor and capital have been employed continually devising new means of increasing its efficiency and adapting it to the increasing requirements of trade and commerce. Science and art, labor and capital, have wrought a revolution. The work of construction and reconstruction is unend- ing. The roadway, terminals and rolling stock suited to the needs of yesterday are inadequate for the necessities of today, and still larger provision must be made for the imperative requirements of to-morrow. The univer- sally urgent and imperative demands has increased car- rying capacity at a minimum cost of maintenance and operation. Hand in hand with this goes the demand for low rates of transportation.

In the rapid evolution of this great instrument of civ- ilization it is not unnatural that abuses should have arisen. As we survey the past we may see how much ex- perience and enlightened judgment have done to eradicate

many of the wrongs which have existed. It is too much to expect of an agency which touches so many, which is so vital to the industrial and social interests of so many people, and which touches those interests at so many points, that all of the inequalities should have been removed. We may hope that a spirit of justice and a larger knowledge may lead to the removal of the present defects and the prevention of evils in the future. The railway, by its very nature, is charged with great public duties. It is in the highest sense a public servant, but it must discharge its functions with impartiality, giving to all whom it serves equality of treatment. Equality of service is the predicate of good relations between the railway and the public. It is of the utmost importance that unjust favoritism should not obtain, that rates should be open and enjoyed by all alike. Nothing so quickly and surely lays the foundation of distress and discontent as secrecy where there should be publicity, as inequality where there should be equality. Rates, transportation charges, must be fixed with a due regard to the owners, the employes and the public. The interests of no one can be disregarded without injury to all. Thus specific steps which invite your consideration are of the utmost importance. Among them are those which seek to predicate and advance the comfort and the welfare of the traveling public and give security to the lives and limbs of the employes, upon whose skill and fidelity the lives and property of so many depend.

Consideration of principles and plans for the retirement and insurance of employes and workmen is in harmony with the progressive spirit which has characterized the great interests in which you are concerned. To provide some measure of relief for those who are incapacitated by accidents or by the infirmities of years is in the highest degree just and praiseworthy. It is predicating upon broad principles of justice, upon broad principles of humanity.

While deliberating upon measures for promoting the welfare of the great interests committed to your care, let us hope that you may cultivate a spirit and a purpose to promote, through the arbitrament of reason, the adjustment and settlement of those problems and questions which sometimes arise to vex and menace international peace. The nation which seeks an honorable settlement of differences with its neighbors in some other way than by an appeal to the sword is not decadent—it is not wanting in international virility; it is simply manifesting the fact that it is keeping step with the progress of civilization, it is evidencing the fact that the barbaric strain has run out of its blood. (Applause.)

Permit me again to welcome you to this international congress and to express the hope that your deliberations may be fruitful of good results to the great interests you have in charge and to all of the peoples from whom you come.

The Chair was then taken by M. Ernest Gerard, first delegate of the Belgian Government, who spoke in part as follows:

It is 20 years since Belgium celebrated the fiftieth anniversary of the opening of the first public railway upon the continent of Europe. Provided for by a law of 1834, the road from Brussels to Malines was opened for business in 1835, in the presence of the celebrated George Stephenson. To-day Belgium has a system consisting of 4,552 kilometers of standard gage road, and 2,722 kilometers of local railways, usually narrow gage, which act as feeders for the main lines. As compared with the area of the country, this development of the steam railway system of Belgium is thus greater than that of any other country in the world, while its proportionate volume of business is surpassed by none. We have, in addition, 800 kilometers (500) miles) of local road, either under construction or chartered. I do not, of course, include in this enumeration the more than 500 kilometers (312 miles) of electric tramways now in operation.

On the occasion of the semi-centennial celebration of 1885, to which I have just referred, there was founded at a Railway Congress, attended by representatives of the majority of the nations of the world which then had railways, the institution which has since become the Permanent Railway Congress. The city of Brussels was chosen to be from that time forward the headquarters of the actual administration of this technical institution. For these reasons you will understand, gentlemen, why, ordinarily, a Belgian member of the executive committee opens the sessions of the Congress.

The first six sessions of the Congress took place in Europe, and the railways of the United States which were represented at the first session by Mr. Jeffrey, who is here present, have from session to session played an increasingly important part. The time has come for the Congress to meet in America, which although not in the strict sense of the term the cradle of the steam railways, exhibits the most rapid local growth of their whole history, and the most surprising examples of progress in their development.

When I reflect on the care which has been given to the organization of this session by the American Railway Association, by the American section of the Congress, especially by the former president, Mr. Sullivan, the present president, Mr. Stuyvesant Fish, by the members of the executive committee, and, let me add, by the two old veterans of the former sessions, Mr. Jeffrey, who was at Brussels in 1885, Mr. Ely, who was at Milan in 1887, and by the active secretary, Mr. Allen; when I think, further, of the courtesies so generously offered by all the railroad companies, I believe, gentlemen, that I express, from the bottom of my heart, a sentiment of gratitude common to everyone of us, when I declare that under such conditions as the present the Congress has before it a prospect of success as complete as could be desired.

Mr. Stuyvesant Fish then took the Chair and made the following remarks:

On behalf of the American Railway Association, which has for many years existed among the railways of the United States, of Canada and of Mexico, and which at Paris, in 1900, invited the International Railway Congress to come here, I have the honor to welcome to the seventh session and to the first held elsewhere than in Europe the delegates named by the governments and by the railways of the 35 countries here represented. The occasion is honored not only by so large an attendance, but also by the presence for the first time as adherents of the International Railway Congress of delegates appointed by His Majesty the Emperor of Germany.

As was said at the fifth session of the International Railway Congress by the present King of England, at that time the Prince of Wales, "Great Britain was the birthplace of railways," and "the first railway constructed under parliamentary powers by money publicly subscribed, was inaugurated for passenger traffic between Manchester and Liverpool in 1830."

In 1829 the directors of the Liverpool & Manchester Railway offered a prize of £500 sterling for a locomotive that would best conform to certain specified conditions, which required each engine to have two safety valves set for a pressure of not exceeding 50 lbs. to the sq. in. and to run over a level track one mile and three-quarters in length, backward and forward ten times, in order to make a total journey of 35 miles. Three engines competed—the "Rocket," built by Robert Stephenson at New Castle; the "Sansparell," built by Timothy Hackworth at Darlington, and the "Novelty," built by Braithwaite & Ericsson in London. The trial took place at Rainhill, near Liverpool. The "Rocket" proved the most successful, and to it was awarded the prize.

This piece of ancient and well-known history is referred to because it was my good fortune to meet some years ago in London Mr. John B. Willcox, who had then been for many years a stockholder of the company in whose service I have been brought up. Mr. Willcox told me that he had taken part in the trial at Rainhill in 1829, as assistant to Stephenson, and said:

"We properly received the prize, as the 'Rocket' conformed more nearly than any other to the specifications laid down by the railroad company; but Ericsson, as subsequent practice proved, had built the better engine."

At the time we had this talk Mr. John Ericsson, a native of Sweden, had long been living in New York as a naturalized American citizen, and was known and honored of all men as the designer and builder of the first turreted ironclad, the "Monitor." John B. Willcox died in England September 7, 1893, and John Ericsson died in New York March 8, 1889. Each of these men had taken an active part in the "birth of the railway" and each lived to see the growth to maturity of the railway system of the whole world as it exists to-day.

A less well remembered fact with regard to America's share in the genesis of the locomotive is that Oliver Evans obtained from the state of Maryland on May 21, 1787, a patent for his, the earliest, high pressure double acting engine, which used steam at a higher pressure than 50 lbs. to the square inch, and applied it on both sides of the piston. Evans' patent particularly describes the application of his engine to wheeled carriages, which could be used even on common roads. A machine of this sort was built by him for the city of Philadelphia in 1804. As no railroads then existed in this country, it traversed the streets for a distance of a mile and a half until it reached the Schuylkill River, where it was placed on board a boat, to which a wheel had been attached at the stern, and propelled this vessel for a distance of 16 miles. Evans' engine was afterward used by the city of Philadelphia for other purposes. His patent for a high pressure engine antedated the English patent of Trevethick & Vivian, which was issued in March, 1802, by nearly 15 years. Of him a German engineer, Ernst Alban, says:

"To Oliver Evans was it reserved to show the true value of a long known principle, and to establish thereon a new and more simple method of applying the power of steam, a method that will remain an eternal memorial to its introducer."

While at the outset there was greater need for railways in America than elsewhere, there was no capital for such enterprises, nor were there shops in which engines could be built or rails rolled as readily or as well as in England. The Baltimore & Ohio Railroad, over which many of you must have come hither from New York; the Delaware & Hudson Canal Company, to the completion of whose works a few miles of inclined planes were essential, and the South Carolina Railroad Company, which built the first 100 miles of continuous railway in this or any country, each separately petitioned Congress at different dates to remit the duties on iron needed in the construction of their lines, showing that the amount [illegible] for rails alone could not be manufactured in this [illegible] within the limited time set in their charters for the completion of their works, and Congress passed an [illegible] release from duty iron prepared for and actually [illegible] railways or inclined planes," which was appro[illegible] July 14, 1832, by President Jackson and remained [illegible] for several years.

In America the problem was to raise capital [illegible] manage in some way to provide means of trans[illegible] where none existed, and very generally to do th[illegible] vance of population and through a wilderness. [illegible] Europe the problem was, with an abundance o[illegible] to merely provide a better and cheaper means of t[illegible] tation which should supplement the existing [illegible] highways and canals. The eagerness of our p[illegible] means of transportation induced them to put u[illegible] service and to endure conditions which would [illegible] moment have been tolerated in more densely se[illegible] more highly organized countries; and our foreign [illegible] will, as they travel through the country, I doubt [illegible] astonished to see trains operated at grade thr[illegible] the streets of populous towns and cities.

It must be remembered that in 1830 the greate[illegible] of this country, practically all that lying westward [illegible] the Alleghany mountains, was unsettled and that o[illegible] pulation was then rural rather than urban. There [illegible] in the United States at that time but one city co[illegible] ning 100,000 inhabitants, and only twenty-two others [illegible] taining 10,000, while at present there are thirty-nin[illegible] cities of 100,000 inhabitants or over, including amo[illegible] them three of upwards of a million each, and four [illegible] dred other cities and towns of from 10,000 to 100,000 [illegible] bitants. In the ten years from 1890 to 1900 the area [illegible] of 129 of these towns and cities was extended by 508 square miles. The tracks now lying in the paved streets of incorporated towns and cities were generally laid on what was, at the time of building, open farming land. To take a particular instance, at the time the first section of the Illinois Central Railroad was opened for traffic in 1852 the limits of the city of Chicago ended at Twenty-second street. Today they extend nearly fifteen miles to the southward thereof, through what in 1852 was open prairie land with scarcely a house in sight.

The welcome which we tender at this time to the delegates, and especially those who have come from Europe, is, if possible, more earnest because, vast as has been the growth of the railroad system on this side of the Atlantic, we in these newer countries must now look more and more to the experience of Europe for light in dealing with the problems which are beginning to confront us on account of our increasing population and civilization. This will involve a vast expenditure of capital, and it may be that when we shall have met and overcome all these difficulties, the capitalization of our railways, which in the United States is now $63,186 per mile, may approach that of the railways of Great Britain, which is £55,495, or, say, $277,475 per mile. While I hardly think we shall go that far, I am certain there must be a very great increase above the figures now prevailing. This because we must now do what they did at the outset—provide second, third and fourth tracks and separate, at least in the densely populated towns and cities, the plane of railway traffic from the plane of street level. Nor is this by any means the only point on which we look to Europe for enlightenment. The preponderance in the older countries of passenger traffic in its relation to freight traffic presents a condition which is confronting us more and more. Already in our Eastern states the proportion of the revenue derived from the carriage of freight—to wit, 54 per cent. of the total receipts from operation—is as low as in Great Britain, although in the interior and in the West the receipts from freight still form upward of 70 per cent. of our total revenues.

Much has been said of late here and abroad about inland transportation by canal. In this connection we must not confuse transportation by steamships on the Great Lakes, which are inland seas on which ply vessels larger than those that traversed the Atlantic 30 years ago. Apart from these lakes, there are two great inland waterways in the United States—the Mississippi river and the Erie canal.

It is within my knowledge that 20 years ago there were annually carried by steamboats from Memphis to New Orleans over 100,000 bales of cotton, and that in almost every year since the railroads between Memphis and New Orleans passed under one management, not a single bale has been carried down the Mississippi river from Memphis by boat, and in no one year have 500 bales been thus carried. The reason being that, including the charges for marine and fire insurance, the rates by water are higher than by rail.

Moreover, in 1890 the tonnage of freight received and delivered at New Orleans by the Mississippi river from all sources amounted to 2,306,290 tons, and in 1900 to 450,198 tons; while the receipts and shipments by rail were in 1890, 3,557,742 tons, and in 1900, 6,852,064 tons.

In 1860 there were carried on the New York canals and on the railroads competing therewith 7,155,803 tons, of which there was handled by canal 65 per cent. In 1870 such tonnage amounted to 17,488,469, of which 35 per cent. was handled by canal. In 1880 the total tonnage was

[illegible]3,633, of which by canal 21 per cent. The tonnage [illegible]900 was 56,327,661, the canal's proportion being 9.3%. [illegible]900 the tonnage was 84,942,988, of which the canals [illegible]ied 4.1%. In 1903 the total tonnage had grown to [illegible]248,299 tons, of which the canals carried but 3.9%. [illegible]ed, the amount carried in 1903 by all the canals of [illegible] York state, including the Erie Canal, 3,615,381 tons, [illegible] less than four-fifths of the 4,650,214 tons carried in [illegible]00.

[illegible]or many years past the function of these and other in[illegible] waterways has been rather to act as a check upon the [illegible]ways in reducing their rates, than in and of themselves [illegible]arry any great proportion of the total or any increased [illegible]nage.

As M. Leroy-Beaulieu has said, the American railways [illegible]e created both the traffic and the production. The [illegible]rliest explorers of the Mississippi valley, the French [illegible]esuit priests, commented constantly upon the fertility of [illegible] soil. Their maps, made as early as 1673, showed coal (charbon de terre) as outcropping along the banks of the [illegible]inois river. But it was not until the railways made [illegible]ommerce among the several states" possible that our [illegible]airies became a fit abode for man, or the mineral and [illegible]rest wealth of the West became available to man. With[illegible]t the railway those prairies would yet be the abode [illegible] the Indian and the bison. For while the earliest settle[illegible]nts of English-speaking people on our Atlantic seaboard [illegible]e made in Virginia in 1607, civilization had not in [illegible]850, except in scattering settlements along the banks of [illegible]rivers naturally navigable, reached one-third of the dis[illegible]tance across the continent. The reports of the engineers [illegible]ent out in 1852 to make the original surveys for the con[illegible]struction of the Illinois Central Railroad across the [illegible]prairies of Illinois refer to their camps being constantly [illegible]invaded by wolves. In short, without railways, civiliz[illegible]ation consumed 250 years in moving less than 1,000 miles [illegible]inland, while in the 50 years which have since elapsed [illegible]we have seen it pass, aided and led by the railway, on [illegible]through arid wastes and over the great chains of moun[illegible]tains which form the backbone of the continent, until to[illegible]day there is no portion of the wide stretch of 3,000 miles, [illegible]from the Atlantic to the Pacific, which is without means [illegible]of rapid and convenient transportation.

Mr. Neville Priestly, under secretary to the government of India, Railway Department, in the conclusion of his report on the Organization and Workings of Railways in America, says:

"Many of the methods are different, often startlingly different, from those one has been brought up to believe the only correct method; and it is not till one realizes that the one idea in the mind of the American railway men is to 'get there,' and that they do 'get there' by the shortest and quickest way, and do not allow themselves to be turned aside either by red tape, old-time prejudices, tradition, or any other of the bogeys by which older countries are assailed, that one understands how the results have been obtained which one sees there. American railway men are quick to see a new idea; they are quicker still to try it; they take a great pride in their profession, and are all striving to get at the science of it. That their methods are not always perfect is what might have been expected; but they have managed to do what no other country in the world has done, and that is, carry their goods traffic profitably at extraordinary low rates notwithstanding the fact that they pay more for their labor than any other country."

At the conclusion of his address, President Fish announced the Temporary Chairmen of the several sections of the Congress as follows: Section I, Mr. Stuyvesant Fish. Section II, Mr. Theodore N. Ely. Section III, Sir Geo. Armytage. Section IV, M. Perouse. Section V, M. Ernest Gerard. This concluded the work of the general session. In the afternoon the delegates and guests, making up a party of several hundred, were taken by boat to Mt. Vernon to visit the home of Washington. The concluding function of the day was a reception in the evening at the Corcoran Art Gallery.

On Friday morning began the regular Section meetings of the Congress, from which the public and the representatives of the press are excluded. In the afternoon the delgates were received at the White House by Vice-President Fairbanks.

On Saturday afternoon after the Sectional meetings were over, a visit was paid to the Capitol and the Library of Congress. Further reports of the proceedings we postpone to a following issue.

RECORDS OF FLOW AT CURRENT-METER GAGING STATIONS WHEN THE STREAMS ARE SUBJECT TO ICE.

By F. H. Tillinghast.*

In the determination of the volume of flow of rivers for conditions of open channel at the ordinary current-meter gaging stations, the methods of the U. S. Geological Survey are well defined and the limits of accuracy are known to be reasonable. For ice conditions, on the other hand, records of gage heights are not uniform, knowledge of the relation of gage height to discharge is meager and estimates of flow are often much in error.

Throughout the northern states the most severe droughts occur in the winter months. Whenever the streams are closed by ice with a low condition of ground water, if the period of cold is long continued, there is sure to result a period of extremely low stages of the river; for during the frozen season no surface water finds its way to the stream, the precipitation being all stored in the form of snow. One or two such periods of low water have been known in which there has been a drought upon the ground water covering a period of nearly six months, and the streams have discharged a smaller amount than has been recorded with open-channel conditions.

It is, therefore, very desirable that there be a full investigation of the whole subject of flow of water under ice, in order to determine the best methods for making discharge measurements, the gage height to be used, and the probable accuracy of the results. None of these matters have received adequate attention and there are comparatively few data bearing upon the subject.

The winter conditions in many rivers vary through a large range, from those which may be called normal, in which the ice remains practically in the position in which it has formed and the stream is quickly closed by a uniform cover of ice, to those where the ice has been broken and is either flowing in large blocks, oftentimes practically filling the whole section of the river, or has been gorged to form temporary dams. To these latter cases no general rules can apply; each must be considered as a problem by itself.

With unbroken ice, fair estimates of flow are possible. There is, however, a wide range in so-called normal conditions of ice, through all stages in ice development from the first fringe along the shore to the solid cover of smooth ice varying in thickness to a maximum of 30 or even 40 inches. With a falling stage of the river the ice cover may not rest entirely on the water, but act in part as a bridge supported on the banks; on the other hand, with a rising stream the pressure of the water under the ice may be greater than that due to the weight of the ice.

There have been made several series of current meter measurements of flow under ice by the hydrographers of the U. S. Geological Survey. The measurements have been tabulated according to increasing gage heights and compared with discharges as obtained from the open section rating table, as shown in Table I.

The results of the measurements in Table I. have been studied to ascertain the effect of the ice cover upon (1) the vertical distribution of velocity, especially upon the position of the point of mean velocity, and (2) the ratio of gage height to discharge, as compared with that ratio for open-channel conditions.

Observations were taken through holes cut in the ice at regular distances across the stream. Velocities were obtained in ten or more points in the vertical and were plotted on cross-section paper, the depth as ordinates and velocities as abscissae. A curve was drawn through the points so determined and divided into ten parts. The center velocities of each part, taken from the curve, added and divided by 10, gave the mean velocity in that section. The accompanying diagram shows a few typical vertical velocity-curves under ice.

When the holes were cut the water rose nearly flush with the surface of the ice, showing that it was flowing under pressure. A study of the tables and curves showed that the flow of water under such conditions was somewhat similar to its flow in pipes and in closed flumes. The mean velocity occurred at two points in the vertical, the average of 101 curves (see Table II.) being 0.11 depth and 0.71 depth; the maximum velocity occurring at 0.36 depth. The curves dragged more for shallow depths and became more concave, and consequently the error of observation increased if the meter were not held at the proper point in a vertical.

Results of the discharge measurements given in Table I. have been plotted on the sheet which contains the rating curve for open-channel conditions, using first the gage height to the surface of the water, and, second, the gage height to the bottom of the ice. The results when plotted with gage heights to the surface of the water have been more consistent among themselves, and have located a curve approximately parallel to the curve for open-channel conditions and lying always to the left of it. The results when plotted with the gage height at the bottom of the ice have not been consistent among themselves, and the curve, which is not so well defined as in the preceding case, crosses the rating curve for open-channel conditions, falling to the right of it in the lower part and to the left of it in the upper part.

From the data at hand, therefore, it appears to be best to use gage heights to the surface of the

TABLE I.—Discharge Measurements With Ice Conditions.

Stream and Place.	Gage Height to Water Surface.	Thickness of Ice in Feet.	Average Depth of Water Below Ice.	Actual Discharge, Closed Section.	Discharge from Rating Table, Open Section.	Coefficient for Reducing Open Section to Ice Conditions.
Wallkill	7.14	1.1	5.4	332	805	0.41
	7.23	2.0	4.6	288	855	0.34
at	7.68	1.1	6.0	597	1,105	0.54
	8.75	1.0	7.2	945	1,765	0.54
Newpaltz,	8.97	1.0	7.4	1,167	1,910	0.61
	10.80	1.0	9.2	2,028	3,250	0.62
N. Y.	11.10	0.8	9.2	2,293	3,494	0.66
(a)	11.40	....	....	3,040	3,746	....
(b)	13.60	....	....	3,277	5,660	....
(a)	15.75	....	....	5,985	7,650	....
	17.23	0.9	15.5	6,063	9,170	0.66
Rondout (a)	6.63	0.3	5.6	222	302	0.73
(c)	6.83	....	....	423	434	....
at (b)	7.43	....	....	772	910	....
(c)	7.50	0.7	6.0	342	971	0.35
Rosendale,	7.93	1.5	5.7	543	1,402	0.39
	7.96	0.5	6.8	676	1,432	0.47
N. Y.	8.61	0.2	7.7	1,185	2,120	0.56
Esopus (a)	5.25	0.3	2.9	245	322	....
(a)	5.47	0.3	3.1	337	376	....
at	6.30	0.1	4.4	476	631	0.75
(a)	6.43	0.1	4.2	522	675	....
Kingston,	6.60	0.8	4.0	425	741	0.57
	6.70	0.3	4.3	530	782	0.68
N. Y. (a)	6.80	0.4	4.6	654	823	....
(a)	9.01	0.3	6.8	1,687	1,947	....
	12.70	0.4	10.8	3,461	5,008	0.68
Fishkill (d)	4.25	0.4	3.5	100	300	0.33
at	4.87	0.5	4.0	202	554	0.37
Glenham,	5.00	0.5	4.0	261	615	0.43
N. Y.						
Catskill (a)	3.30	0.4	2.5	110	120	0.91
at (a)	3.50	0.8	3.0	148	152	0.97
So. Cairo,	4.72	1.0	3.0	363	660	0.55
N. Y.						
Connecticut	4.03	2.0	5.0	799	1,765	0.45
	4.03	2.0	5.0	790	1,765	0.44
at	4.08	2.0	5.0	785	1,800	0.44
	4.12	1.9	5.0	876	1,820	0.48
Orford,	4.15	1.9	5.0	884	1,845	0.48
	4.20	2.0	5.0	792	1,880	0.42
N. H.	6.60	1.2	7.0	2,620	4,120	0.63
	6.90	1.4	7.0	2,690	4,450	0.61
	7.20	1.2	7.0	2,970	4,780	0.62
	7.40	1.4	7.0	2,980	5,000	0.60
	7.45	1.4	7.0	2,990	5,055	0.59
	7.45	1.4	7.0	3,030	5,055	0.60

Notes a. Partly open channel.
b. Ice piled up along banks.
c. Anchor ice.
d. Water backed up.

TABLE II.—Position of Mean and Maximum Velocities in a Vertical Plane Under Ice.

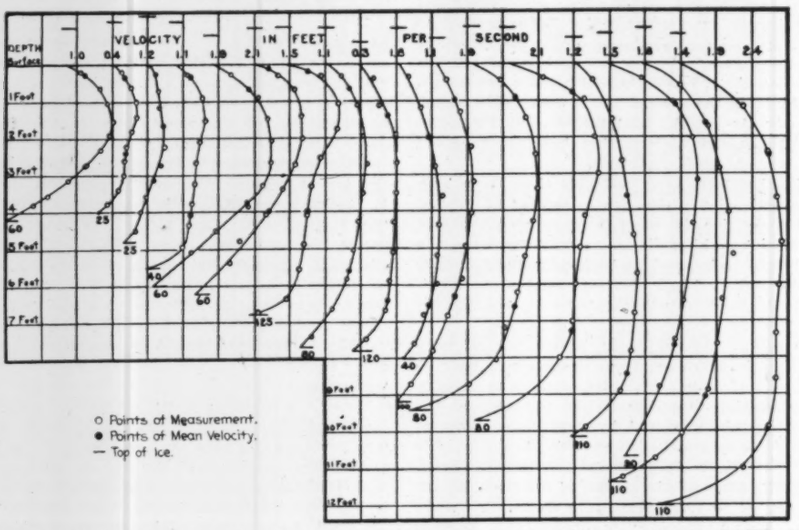
Stream and Place.	Depth from Under Surface of Ice, Feet.	Number of Curves.	Depth of Mean —Velocity.—		Depth of Maximum Velocity.	Coefficient to Reduce Maximum to Mean.
Wallkill at Newpaltz, N. Y. (a)	4 to 12	20	0.12	0.71	0.38	0.85
Wallkill at Newpaltz, N. Y. (b)	4 to 19	26	0.13	0.74	0.38	0.86
Esopus at Kingston, N. Y. (a)	2.3 to 7.4	16	0.08	0.68	0.36	0.80
Esopus at Kingston, N. Y. (b)	5 to 8	8	0.11	0.73	0.37	0.85
Rondout at Rosendale, N. Y. (a)	4 to 8	5	0.08	0.68	0.35	0.82
Rondout at Rosendale, N. Y. (b)	5 to 7	8	0.13	0.71	0.35	0.86
Connecticut at Orford, N. H. (c)	2.5 to 7.7	18	0.11	0.69	0.35	0.85
Mean			0.11	0.71	0.36	0.84

Notes: a. By F. H. Tillinghast.
b. By W. W. Schlecht.
c. By C. A. Holden.

*Assistant Engineer U. S. Geological Survey, Washington, D. C.

water as it rises in the hole cut in the ice, and a comparison of the ice rating curve so plotted with the open-channel rating curve is given in Table III.

In Table III. are given values of the coefficient which must be applied to the rating curve for open-channel conditions in order to give an estimate of discharge under ice when the gage is read to the top of the water. It will be noticed that



CURVES SHOWING THE VELOCITY OF WATER FLOWING UNDER ICE; WALKILL RIVER, AT NEW PALTZ, N. Y.

(Current-Meter Measurements Taken at Various Depths.)

the coefficient to be used varies between .46 and .75, with a mean of .60. Isolated measurements have been made with thicker ice and comparatively small depths which give coefficients as low as .30. If ice conditions are not known in detail, therefore, an estimate based on a coefficient of .60 would probably be most nearly correct. It seems probable that further investigations will enable us to determine upon a sliding coefficient varying between .30 and .75, the value of which for each case shall be determined by the thickness of the ice, or the ratio of the thickness of the ice to the depth of water, and from which we can obtain more reliable estimates.

It is urged that in making measurements of flow under the ice in the future the record be made as complete as possible. The vertical velocity-curve method should be used, and data in regard to the nature of the ice at the section, and above and below it, the gage height of the water as it rises in a hole cut in the ice, the gage height of the bottom of the ice, the thickness of the ice and any other attendant conditions which may even remotely affect the discharge, should be recorded, in order that in further study of this subject all possible data may be at hand.

TABLE III.—Relation Between Discharges From Open Section and Ice Rating Curves, with Coefficients.

Stream and Place.	Gage Height.	Discharge from Ice Rating Curve.	Discharge from Open Section Rating Curve.	Coefficient for Reducing Open Section to Ice Conditions.	Mean Coefficient.	Greatest Range from Mean Coefficient.	Weight Given Results.
	8.0	650	1,290	0.50			
	9.0	1,125	1,930	0.58			
Wallkill	10.0	1,640	2,630	0.62			
at	11.0	2,180	3,410	0.64			
	12.0	2,760	4,250	0.65			
Newpaltz,	13.0	3,360	5,120	0.66			
	14.0	3,980	6,020	0.66			
	15.0	4,610	6,940	0.66			
N. Y.	16.0	5,240	7,890	0.66			
	17.0	5,920	8,930	0.66			
	18.0	6,575	10,000	0.66			
					0.63	0.13	3
	8.0	688	1,472	0.47			
Rondout	8.5	1,040	2,000	0.52			
at	9.0	1,425	2,539	0.56			
Rosendale,	9.5	1,840	3,102	0.59			
N. Y.	10.0	2,290	3,700	0.62			
					0.55	0.08	2
	6.0	320	527	0.61			
Esopus	7.0	625	905	0.69			
	8.0	1,010	1,373	0.74			
at	9.0	1,470	1,940	0.75			
	10.0	1,980	2,642	0.75			
Kingston,	11.0	2,520	3,440	0.73			
	12.0	3,075	4,340	0.71			
N. Y.	13.0	3,650	5,305	0.69			
					0.71	0.10	1
	4.2	140	284	0.49			
Fishkill	4.5	210	380	0.55			
at	4.8	280	521	0.54			
Glenham,	5.0	330	615	0.54			
N. Y.	5.2	400	737	0.54			
					0.53	0.04	1
Catskill, at So. Cairo, N. Y.	4.7	363	660	0.55	0.55	....	1
	4.0	890	1,740	0.46			
Connecticut	4.5	1,100	2,110	0.52			
	5.0	1,400	2,520	0.56			
at	5.5	1,700	2,970	0.57			
	6.0	2,050	3,470	0.59			
, Orford,	6.5	2,400	4,010	0.60			
	7.0	2,750	4,560	0.60			
N. H.	7.5	3,100	5,110	0.61			
	8.0	3,500	5,660	0.62			
					0.57	0.11	1

Total mean coefficient.....0.595 or about 0.6

GOOD TASTE IN CONCRETE BLOCK CONSTRUCTION.*

By Louis F. Brayton.†

Within the last couple of years, a new field for concrete construction has been opened in the shape of the concrete building block. Two years ago its use in molded blocks as a substitute for stone was a mere rumor. To-day there are in the neighborhood of 200 companies in the United States, whose business is the manufacture of machines for the molding of concrete blocks.

Blocks can be made in an infinite number of forms appropriate to the material, or in imitation of stone.

In connection with this particular point, it seems a pity that there should be so much imitation and so little attempt to produce an article which would not proclaim all over its face the fact that it is supposed to be something else. Great quantities of so-called "rock-faced ashlar" concrete blocks are being manufactured and used in the construction of foundations or for the facing of buildings. The rock-face is clearly intended to have the appearance of stone, but the deception is an utter failure.

Why should this be? Why should not blocks be treated like the concrete from which they are made? For instance, if a concrete contained, as an aggregate, crushed granite, or marble, possibly varied in colors, or if gravel of various types were used, a surface having all the rustic advantages of rock face, but at the same time, the characteristics of the material used would be produced by the brushing out of the mortar slightly on the surface, leaving exposed the pieces of broken stone, gravel or seashells as the case might be. Concrete blocks using this feature or some other method of treatment appropriate to the material would be far more popular than those now produced, and at the same time no more expensive.

*Extract from a paper read April 11 before the Northwest Railway Club.

†President Brayton Engineering Co., St. Paul, Minn.

COST OF GOLD DREDGING IN CALIFORNIA.—When hydraulic mining was at its height in California, and was carried on without restriction, the cost of washing the gravel per cubic yard was reduced to a figure so low that this class of mining came to be acknowledged as the least expensive in the world, for the amount of material moved. There was considerable variation in this expense at the various mines, it is true, dependent on the thickness of the gravel deposit, the available grad[illegible] amount and pressure of water obtainable, as well [illegible] character of the gravel itself, but most of the [illegible] mines operated at a cost ranging from about 3.7 c[illegible] or 8 cts. per cu. yd. At that time no one thought [illegible] a few years dredging for gold would become a g[illegible] dustry, or if anticipated, that the cost of mining [illegible] method would compare favorably with the cost [illegible] draulicking on a large scale, but such is to-day [illegible] for dredging in California has been reduced, in [illegible] ville region, to a figure corresponding closely w[illegible] of operating the great hydraulic plants of the [illegible] well equipped dredge of large capacity, and gra[illegible] does not offer too many difficulties to its hand[illegible] wash gravel at a cost of about 5.5 cts. per cu. yd. [illegible] and Scientific Press.

DIAMOND DRILLING as a means of locating [illegible] bearing reefs of the Transvaal has been in gener[illegible] for many years. Unusual interest attaches to it at [illegible] ent time owing to the large number of deep ho[illegible] which are being sunk to prove the existence and positi[illegible] the ore bodies at increasing distances from the outc[illegible] For this work larger and larger drills have been used and within the past year or two numerous bore holes have been bottomed in ore at depths of from 4,500 to [illegible] ft. Upward of 300 diamond drills are now in use in South Africa, the prevailing types being the Sullivan and Bullock, manufactured by the Sullivan Machinery Co., of Chicago. The mining companies as a rule let the work to contractors, who furnish all the equipment and expert operators, and deliver the core into the hands of the company. American contractors have recently broken all records for depth. James Tobin completed a bore hole last December at Doornkloof, 16 miles west of Randfontein, at a depth of 5,560 ft. The first 3,200 ft. were bored with a Sullivan size "N" drill, rated capacity 2,000 ft.; a size P drill of latest improved pattern with rated capacity of 4,000 ft. was then put in commission and continued the hole until its completion at 5,560 ft.; 700 ft. of size N rods removing 2-in. core were used, the remaining 4,860 ft. being B, removing a 1⅝-in. core. The total load of these rods was between 15 and 16 tons, which was handled by the engine without difficulty. The actual running time of this hole was 14 months, or an average of nearly 400 ft. per month. For the first two months two ten-hour shifts were used and for the balance of the time the work was carried on the whole 24 hours, divided into three eight-hour shifts. The rods were pulled in lengths of 60 ft., the height of the tubular steel derrick being 66 ft. over all. The time required to lower the rods at a depth of 5,000 ft. was from 3 to 3½ hours, and from 3½ to 4 hours was required to lift them.

This record has since been beaten by a hole sunk near Springs, east of Johannesburg, by John Skenke. This hole was begun May 1, 1904, and completed Feb. 2, 1905, at a depth of 5,582 ft. A size "P" drill was also used here, power being supplied by a 30 I. HP. boiler; 1,000 ft. of "E" (2-in. core) rods were used, the remainder of the equipment being similar to that used by Tobin.

A GOLD-SAVING PROCESS for treating the slimes or fine waste from cyanide mills is being introduced, and is known as the Moore slimes process. The patents are owned by the General Metals Co., of New York, and the plant is manufactured by the Allis-Chalmers Co., of Milwaukee, Wis. There is a filter composed of 18 parallel "plates," 20 ft. long and 4 ft. high, each plate having a rectangular frame covered on both sides with cloth. Air and vacuum pipes pass through the top bar of each frame, and are connected to headers leading to vacuum and air pumps mounted on the steel channels from which the filter is suspended. The filtering area is 2,880 sq. ft. The slimes from the mill, after treatment with cyanide of potassium flow into the first compartment of a tank, which has a second compartment for a weak cyanide solution, and a third compartment for wash water. The filter, which is carried by a traveling crane passing over the tank, is lowered into the first compartment, and the vacuum pump started; this causes the gold solution to pass through to the interior of each "plate," until in about one or two hours the slime or fine dirt has coated the filtering surfaces to a thickness of an inch. The filter is then hoisted out and lowered into the second compartment for 20 minutes and into the third compartment for 10 minutes. It is then finally raised and carried to the point of discharge, when air is blown into the pipes, dislodging the accumulations on the filter cloth, which fall into cars standing below. The process has been used at the Mercur mine, in Utah; the Bodie mine in California, and the Buxton mine in South Dakota. Contracts were closed last fall for the erection of two large plants in Australia. A trial plant was installed some months ago at the Homestake mine, in South Dakota; the slimes from the mill amount to 1,200 tons per day and carry 80 cts. of gold per ton. The Moore filter recovered 60 cts. of this at a cost of 15 cts., showing a net gain of 54 cts. per ton of slimes. The process can be economically applied to the treatment of low-grade gold ores, and is said also be cheaper and more effective than the decantation and filter-press methods, and these are not applicable to low-grade ores.

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The American Railway Appliances Exhibition, held at Washington for the past ten days in connection with the International Railway Congress has been so notable as to overshadow in technical importance even the work of the Congress itself. It is probably the most complete exhibition of American railway material, tools and appliances that has ever been assembled, not even excepting the remarkably good exhibit at St. Louis last year.

An equally notable fact is that the whole exhibit has been created and installed in an almost incredibly brief space of time. In just 43 days from the time the first timber was brought onto the grounds, an exhibition was created involving an expenditure of over a million dollars. Indeed it is safe to say that the total outlay of American manufacturers of railway supplies in connection with the Exhibition and the Congress, including salaries and expenses of the members of their force in attendance will exceed two million dollars. As Secretary Taft well said: "If it will pay a manufacturer to spend as much money as must be spent here in order to get through our heads what is necessary for the improvement of the world, how stupid the minds of men must be!"

Nevertheless, those who are showing their appliances at the exhibition appear entirely satisfied with the results. They well understand that numbers count for nothing in such an exhibition as this. The presence of one railway officer is of more importance to the exhibition than that of a hundred who are drawn to an exhibition by mere curiosity. And the high character of the railway officers who have carefully studied the exhibits at Washington has been exceedingly gratifying. It has been fully recognized that the exhibition was one of great educational value and that it was a benefit to the railway companies to have their active operating officers go there to study and learn.

New York City has fared better at the hands of the legislature which adjourned on May 5 than many people expected. All the legislation on gas and electric light and power in New York City, recommended by the investigating committee, was passed, with some modifications, except the bill reducing the price of gas from $1 to 75 cts. a thousand. This bill was killed, but the reduction may yet be secured, although most likely by degrees, through the State Gas and Electric Commission created by one of the bills. As we said in our issue of April 27, a permanent commission is a more suitable body to regulate lighting rates than a legislature, and a commission may be of great service to the whole State. It is generally believed, however, that reasons other than public policy caused the killing of the bill reducing the price of gas in New York City.

The idea still prevails in some quarters that home rule is violated by the creation of the commission, and some civic organizations are reported as having worked against the passage of the bill, and as now working against its approval by the governor. The presumption is that these bodies think direct legislative interference less a violation of home rule than control by a commission of experts created by the legislature. We think those civic bodies that have made the most careful study of municipal government are almost unanimously in favor of a delegated central administrative control rather than a direct control of municipal affairs by the legislature. In the case of gas and electric lighting, legislative control is entirely out of the question, since the control must be exercised constantly, and the legislature is in session only a small part of the year. It may be noted in closing that hereafter the price of electric current in the borough of New York and the most thickly settled part of the Bronx will be 10 cts per KW. hour, and in Kings Co. (Brooklyn) 12 cts. The main features of the other bills in question were stated in these columns in our issue of April 27.

The "middle-third" rule for proportioning cross-sections of masonry in compression is so familiar that its underlying reasons and its limits of application are rarely given thought. In fact, there are perhaps many engineers who, though knowing in quite definite terms the reasons on which the rule is founded, are unaware that it has a strictly limited field of application, outside of which its use may be dangerous. A case recently came before us where this lack of knowledge (or forgetfulness) was evidenced, which will serve to justify the present reminder.

The middle-third rule may be stated as follows: In masonry which is required to bear eccentric loads, or lateral bending moments superimposed on central loads normal to the joint surfaces (or corresponding planes of weakness), the resultant of all the pressures on any joint face should pass within the middle third of width of that joint. For, when the resultant lies outside the middle third, the stress at the opposite edge of the joint is tension—an undesirable condition in masonry—or (in case the joint is incapable of tensile resistance) the pressure area is confined to a width less than the joint width, and the joint tends to open. When the resultant lies in the boundary of the middle third, the whole joint is exposed to compression and the stress at one edge is just zero. This is, therefore, universally considered the limiting condition for ordinary masonry.

If it be objected that the tendency of the joint to open is of no importance, the explanation may be put in another form. When the resultant is central to the joint surface, the compressive stress is uniform over the whole section. As the resultant moves away from the center, the compressive stress at one edge increases and at the other edge decreases in linear ratio to the bending moment, until the resultant reaches the limit of the middle third, at which time the stress at one edge is twice the uniform pressure and the stress at the other edge is zero. But as the resultant moves out of the middle third, the extreme compression (in masonry incapable of tensile resistance) increases at a much higher rate than before, in fact, on a hyperbolic curve of increase, reaching a value of infinity when the resultant passes through the edge of the masonry. Of course, failure by crushing of the material, and consequent failure by overturning, takes place before this value is reached; but the point is, that so long as the resultant of external forces lies within the middle third, the bending moment calls into play a stress only directly proportional to it, while outside that limit the material is stressed at a rapidly increasing rate, out of proportion to the increase in bending moment.

This may be studied in very illuminating manner by a comparison of real and apparent factors of safety in various positions of the resultant. *Apparent* factor of safety here means the quotient obtained by dividing ultimate crushing strength of the material by maximum compressive stress occurring under the assumed conditions; *real* factor of safety, on the other hand, is the quotient of value of bending moment required to produce a maximum stress equal to the ultimate strength, divided by actual bending moment under the assumed conditions. It requires no strained assumptions to find a case where the real factor of safety is only 1¾ while the apparent factor of safety may be as high as 8 or 10. Such discrepancies, it should be said, are not peculiar to resultants lying outside the middle third, since even at the middle-third boundary the real factor of safety is always slightly less than 3. But outside the middle-third limit the real factor of safety drops off rapidly, and soon comes dangerously close to unity.

This lengthy disquisition is given to reinforce the argument that, in designing, the resultant should be kept within the middle third, or rather, within the limit corresponding to the conventional middle third. This brings us to the point mentioned at the beginning.

The mathematical foundation of the middle-third argument involves the tacit assumption of a rectangular cross-section. If the section is other than rectangular, the details of the mathematical demonstration change, and the "third" is transformed into some other fraction of the joint width. Thus, for a circular cross-section, the fraction is one-fourth, a quantity fully 25% smaller than the "third." For a section enlarged at the outside—a case which might conceivably occur—the fraction is larger than one-third. Rectangular sections are, of course, almost universal in masonry work. But exceptions, though rare, do occur. Foundations and pedestals of various kinds are at times made circular in ground plan; they may be octagonal, or of similarly varied form. Piers of rounded, or sometimes nearly circular, section may occur, under conditions that expose them to inclined thrust or other bending action. In all such cases serious error against safety may be made by blind use of the middle-third rule. Rare as the cases may be, their very rarity justifies reference to the fact that their design involves other factors than those applied to simple rectangular sections.

THE PHILADELPHIA GAS LEASE EXTENSION SCANDAL.

The municipal conscience of Philadelphia is proverbially somnolent. By municipal conscience is meant those inner promptings which cause the governments and the voters of cities to give more or less frequent heed to the public interest as opposed to partisan and personal ends. At rare intervals the citizenship of Philadelphia bestirs itself and frightens councils and the generally irresponsible and irresponsive powers back of them into some action or cessation of action which can be effected in no other way; but unfortunately for Philadelphia, these exhibitions of citizenship never last until the next municipal election.

What bids fair to be the worst scandal in the municipal history of Philadelphia, if not of the world, received a temporary check last week through one of these rare awakenings of the citizens of Philadelphia. To even partially appreciate the situation it is necessary to go back a bit.

For many years the Philadelphia city councils played fast and loose with the municipal waterworks and gas plants. After numerous attempts to turn the water-works over more or less completely to private capitalists, public sentiment finally asserted itself so strongly as to commit the city irrevocably to a continuation of municipal ownership. Meanwhile the gas works were deliberately starved to death and virtually wrecked through the appropriation of their revenues to other city purposes, thus making easy their lease in 1897 to the United Gas Improvement Co. That lease still has more than twenty years to run, but it contains an option permitting the city to regain possession of the works in 1908 by reimbursing the company for its capital outlay in improving

the works, plus a high rate of interest. If the city does not exercise this option the works revert to it in 1928, and no payment is made for the improvements to the plant. The lease also provides for substantial and increasing reductions in rates to private consumers or, at the option of councils, the payment into the city treasury of equivalent sums on every thousand feet of gas sold. Thus far the city treasury and not the private consumer has been getting the benefit of this provision.

Since the "water snake" was scotched and the city of Philadelphia committed to a continuation of municipal ownership of the water-works, it has been expending some $20,000,000 to $30,000,000 on their improvement and extension, including the largest filtration plants in the world. This huge expenditure might have been greatly reduced had the city authorities heeded the advice of eminent engineers and taken steps to cut down the immense water waste known to exist, thus greatly reducing the scale of the improvements. It is also the opinion of some good engineers that the water-works improvements, even on their present scale, are needlessly expensive.

Into these questions of excessive size and cost of the water-works improvements we need not go. They certainly form a strong contrast to the starving of the gas works, already mentioned, and in connection with other heavy public expenditures may have some bearing upon the sudden discovery by councils that a large sum of money was urgently needed for city work and could be readily secured by modifying and extending the lease of the gas works.

However, all this may be, the people of Philadelphia waxed wroth when they learned that arrangements were perfected for extending the lease of the gas works for 50 years from 1927, and for surrendering any further increase in the contract rate paid to the city per thousand of gas sold and for continuing the price of gas at $1 a thousand after 1927. Of course, with all this the city cut itself off from taking back the works and operating them itself in 1908.

The transaction thus proposed was made plausible by a proposed payment to the city of $25,000,000 in cash, within some three years. This looks large and is large, by itself, but compared with the privileges which the city both surrendered and gave it is believed to be paltry.

The public press of Philadelphia lost no time in denouncing the proposed transaction, and the citizens were not far behind. Just before the date set for rushing the matter through councils, Mayor Weaver sent them a communication disapproving the extension in strong terms, advising that competition be invited, but favoring a resumption of municipal operation, and urging that the city was not in such desperate financial straits as to make it necessary to raise funds by such questionable means. Mayor Weaver's letter contains so much interesting information that we print it in full, as follows:

Gentlemen: I have received information that an ordinance has been introduced into your honorable bodies to extend the present lease of the Philadelphia gas works to the United Gas Improvement Company for a long period of years for the consideration of twenty-five million of dollars. I have read over the proposed lease very carefully and would say without the slightest hesitation that it would be most improvident to pass the proposed ordinance extending the lease. Under the present lease the gas company is at present paying to the city ten cents for every thousand feet of gas consumed, and in 1908 this is increased to fifteen cents; in 1913 to twenty cents, and in 1918 to twenty-five cents. Under it the city will receive at the very lowest estimate over thirty millions of dollars in these payments before the expiration of the thirty-year lease. But in case it should be your judgment that there should be a new lease after the expiration of the first ten years, at which time the city has the right to cancel the lease by paying back to the United Gas Improvement Company what they have laid out for improvements and betterments, then surely this should only be done after proper advertisement and then award to the highest bidder.

Up to the present time the United Gas Improvement Company claims to have expended about ten million six hundred thousand dollars in improvements, betterments, etc., and there is no doubt that a lease of the gas works for any considerable length of time is worth a very large amount of money. I have always advocated the retention of public utilities by the municipality, and it seems to me that now is the opportunity for the return to the city of Philadelphia of its gas works. The city has a borrowing capacity now of upward of fifteen million dollars. They have five or six million dollars unnegotiated or still awaiting contract from previous loans, and I earnestly urge your honorable bodies, before any action is taken, to have a careful statement made of the finances of the city, as I am positive there is no necessity for a large amount of additional money at this time, and I also urge that if it should be the deliberate judgment of your honorable bodies that it would not be wise to take back the gas works at the expiration of the ten years' term, to wit, in 1907, that then any proposed extension of lease should be the subject of advertisement and award to the highest bidder.

Before the council met to vote for the lease, a large crowd of citizens assembled in front of the city hall, indulging in nothing worse than speech-making. But previously many silent influences, such as coat lapel buttons with significant legends and letters of protests, had been at work. Besides there had been public meetings and an effective newspaper campaign.

Instead of passing the lease extension the following resolution was passed, almost without discussion or opposing votes, by both Select and Common Councils:

Resolved, by the Select and Common Councils of the city of Philadelphia, That the chairman of the Committee on Finance is authorized and directed to advertise in all the daily papers of Philadelphia that bids for leasing the Philadelphia gas works will be received until Monday, May 15, at 12 o'clock noon, at the office of Clerks of Councils and publicly opened in the presence of the Committee on Finance at that time in Room 496, City Hall; all bids to be accompanied by a certified check in the sum of $250,000. The expenses of said advertisements to be taken out of item 7 in the annual appropriation to the Clerks of Councils.

Could anything be more farcical! Ten days for the preparation of bids for the lease of the gas works of a city of 1,500,000 inhabitants, under unusually complicated conditions, the latter including the fact that the city cannot lease the works to another company until it terminates the present lease, a condition of which is to pay the present lessee the cost of improvements made by it. But even such a concession to public opinion is something—in Philadelphia. It may be that the people of that city, instead of being quieted by the sop or deceived by the indefinite results likely to follow the advertisement, will continue to assert themselves and doing so insist on some weeks or months of deliberation, aided by expert engineering, financial and legal advisers, before taking any further definite action on so important a matter. After full investigation and free discussion, if it were decided that a *short* extension of the lease were desirable, or that its desirability was worth testing by soliciting bids, then common sense would suggest six to eight weeks' advertising for bids under carefully prepared specifications.

But why extend a lease yet having over twenty years to run and containing a provision for a return to municipal ownership three years hence? No valid reason seems to have been given thus far, and we doubt if one can be found.

LETTERS TO THE EDITOR.

A Formula for Crown and Skewback Depth of Masonry Arches.

Sir: Herewith I send you two equations which I would be pleased to have you submit for the criticism of your readers. During the past few months the subject of crown-thickness of masonry arches has repeatedly been mentioned in your correspondence columns. In your issue of July 14, 1904, one correspondent asked directly for just such a formula as those I submit.

Let

T = thickness of arch-ring at springing-line, in feet,
t = thickness of arch-ring at crown, in feet,
H = rise of arch, in feet,
S = span of arch, in feet,
w = weight of the arch masonry, in pounds per cubic foot,
d = crown depth of surcharge,
C = safe pressure in arch-ring, in pounds per square foot,
L = length of the line of resistance of the arch-ring,
ϕ = the angle of slope of rib at springing.

Then the following equations give the mathematical relation from which T and t may readily be found:

$$T = \frac{w\,H\,d}{C - (C + w\,H)\cos\phi} \qquad (1)$$

and

$$t = T\cos\phi$$

in which,

$$\cos\phi = \frac{L^2 - 4H^2}{L^2 + 4H^2};$$

and in all practical cases

$$\text{Cos}\,\phi = \frac{3S^2 + 4H^2}{3S^2 + 2SH^2} \text{ (approximately)}$$

Example 1—Let S = 220 ft., H = 57¼ ft., w = [illegible] lbs. d = 10 ft. and C = 65,000 lbs. per sq. ft. [illegible] cos ϕ = 0.668 and

$$T = \frac{160 \times 57.25 \times 10}{65{,}000 - (65{,}000 + 160 \times 57\tfrac{1}{4})\,0.668} = \frac{91{,}600}{15{,}461}$$

$$t = 5.92 \times 0.668 = 3.95 \text{ ft.}$$

Example 2—Let S = 500 ft., H = 20 ft., d = [illegible] ft., w = 150 lbs., C = 100,000 lbs. per sq. ft. Then [illegible] = 0.9874 and

$$T = \frac{150 \times 20 \times 2}{100{,}000 - (100{,}000 + 150 \times 20)\,0.9874} = \text{a negative}$$

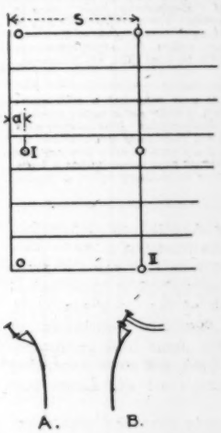
and therefore an imaginary value for T.

The equation shows that no arch can be built when $C - (C + w\,H)\cos\phi < 0$.

Yours truly, C. H. Wallace, C. E.
St. Helena, Napa Co., Cal., April 14, 1905.

What is Eccentric Loading of Columns?

Sir: What is "eccentric loading" of columns? Will you or any or your readers be kind enough to enlighten me on the above question?



I understand that in ordinary practice a column such as Col. I in the sketch herewith is considered to be eccentrically loaded, while Col. II is not. The connection can be made practically as efficient in the one case as in the other. How does the column know the difference?

It seems to me that all wall columns, for example, are subject to a bending moment, no matter how the connection is made, as long as it is a stiff connection. Suppose that each floorbeam in the sketch carries a load W. The column load (Col I) will then be $\frac{12\,W}{7}$. Is then the bending moment on Col. I equal to $-\frac{12\,W}{7} \times a$ or to $+\frac{12\,W}{7}\left(\frac{S}{4} - a\right)$?

If the former, then the column would bend as indicated in sketch A, but will not the column really bend as in B on account of the deflection of the floorbeams, provided all connections are stiff? J. M. J.

Mexico City, Mexico, April 23, 1905.

(The question offers opportunity for a full explanation of this subject, which we trust to receive from one of our readers. The behavior of building columns is many sided and by no means simple, and probably very few structural men have studied the subject to its fullest extent. While numerous discussions on the subject of columns, among them several in the matter of eccentric loading, have appeared in our columns, ample opportunity still remains for valuable treatment of the problem of columns and their connections.—Ed.)

Elementary Demonstrations of the Correctness of the Prismoidal Formula.

Sir: The prismoidal formula may easily be proved correct by taking a typical case of the prismoid, resolving into simple geometrical solids, computing the total volume and comparing this with the volume given by the prismoidal formula.

As a familiar example take one "station" of railroad embankment. For convenience assume a crown width of 14 ft. with slopes 2 to 1. Assume the ground surface to be a plane, with horizontal lines normal to the center line. Assume the fill at Station 1 to be 10 ft., and at Station 2 to be 20 ft.

Pass a horizontal plane through the base line AB at Station 1 (see figure), which cuts the cross-section at Station 2 in the line CD, and cuts the side slopes in the lines AC and BD. Pass vertical planes through AC and BD, cutting the base in AG and BE. The whole prism is now divided into four regular geometrical figures—one regular prism above the plane A B C D, one triangular prism directly under that, and one triangular pyramid on each

the slopes. Compute the contents of the four component figures and take their sum, which is the exact content of the whole prism.

Take a middle cross-section at M (Station 1 + 50) and compute the contents of the "station" by the prismoidal formula.

The two results are exactly the same.

It is interesting to note that the computation by mean end areas gives an excess over the true quantity which is exactly equal to the content of one of the triangular pyramids—as D E F B. From which a rule for correction can readily be deduced. T. G. D.

Clarksdale, Miss, April 15, 1905.

Sir: An interesting demonstration of the prismoidal formula was given in your issue of the 6th instant.

In explaining this formula I have found it helpful to consider the general case where the prism, cylinder, pyramid, cone and wedge are regarded as the elements of the prismoid, rather than particular instances of the latter, and then show that the prismoidal formula is applicable to finding the volume of any one of these elements, and hence is a correct volume formula for any combination of the elements provided they all have the common altitude, h.

The cylinder is a special form of the prism, and the two have the same formula for volume. The same is true with respect to the pyramid and cone; hence the prism, pyramid and wedge may be considered as the elements of the prismoid.

It should be noted also that a frustum of a pyramid or wedge may be resolved into a prism and one or more of the other elements of the prismoid.

Take the pyramid, for example; let the areas of the lower, middle and upper bases be denoted by A_1, A_m and A_2, respectively. The ordinary formula for volume may first be written

$$V = \frac{h}{3}(A_1) \qquad (a)$$

Now write the parenthesis

$$(A_1 + 4\,A_m + A_2). \qquad (b)$$

Since $4\,A_m = A_1$, and since $A_2 = 0$, the value of the parenthesis in (b) is twice that in (a), and may be substituted for the latter if the coefficient in (a) be divided by 2, thus giving

$$V = \frac{h}{6}(A_1 + 4\,A_m + A_2).$$

But this is the prismoidal formula, and in a similar manner it may be shown that it is the volume formula for the prism and wedge as well.

Respectfully, Frank T. Daniels.

1 Ashburton Place, Boston, Mass., April 18, 1905.

More Concerning Expansion Bearings for Bridges.

Sir: In your issue of April 27 you publish a paper by Francis S. Rice with an anomalous title and an editorial. Both of these articles, as well as the entire discussion of the matter, are altogether beside the mark, as not one of the speakers or writers seems to know what are the primary functions of "expansion bearings."

Permit me first to give some definitions:

Crushing or thrust stresses are produced by loads tending to shorten.

Tension stress is the force per unit area resisting loads applied.

Strain is change of length ± under stress in either direction.

There is no such thing as "compression" in a structure.

There is no such thing as "elastic limit" ever determined by any one testing materials used for structural purposes.

The Yield Point is, however, determined generally with a great degree of inaccuracy and carelessness.

A bridge in order to be properly designed should be submitted to a mechanical engineer who is conversant with and cognizant of motions at all hinges and joints. A civil engineer (American definition) deals only with fixed stresses, and almost invariably neglects dynamic stresses and effects. Every pin-connected truss bridge is a machine and not a fixed structure. There is motion at the ends and at every pin connection. This is the reason why all American pin-connected trusses wear out in short spaces of time, instead of lasting indefinitely.

An expansion bearing should be primarily designed to take care of all possible motion during protracted periods, and oft repeated, and should not wear during such time and action.

The most important function of an expansion bearing at one end of a bridge—the other end being fixed—is not to provide for occasional slow temperature expansion, but primarily for the oft-repeated rapid changes of length due to moving trains, especially under high speeds.

An expansion bearing not designed to meet these conditions is an abortion and cannot meet the conditions which are imposed upon or surrounding it.

There are, in the writer's knowledge, just three bridges in this country which are provided with properly designed expansion bearings, while a fourth, the Brooklyn bridge, may be included in this class.

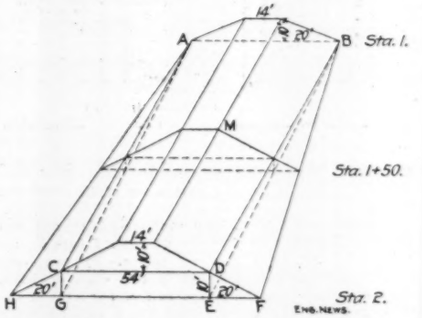
The expansion bearing of the main channel span of the first bridge thus designed, the Henderson bridge across the Ohio River, is the result of the writer's suggestions as used in the design by the late F. W. Vaughan, Chief Engineer. The second is the reconstructed Cincinnati-Covington bridge, designed and built by Mr. Wm. Hildenbrand, with a few suggestions by the writer.

The third, which is somewhat questionable but probably well acting accidentally, is the Williamsburgh bridge, the cables of which were also designed and built by Mr. Wm. Hildenbrand. The saddles and roller-beds of this bridge should be housed and lubricated with vaseline.

When the old East River bridge was built, steel castings were unknown; hence a cast-iron saddle rests on steel rollers, on a cast-iron bed-plate. The steel rollers produce deep elastic depressions in the upper and lower bearings, and hence these saddles cannot move except under excessive differences in forces on opposite sides of the towers. They are not kept lubricated and snow and rain are not excluded. Hence they must be considerably corroded. The writer has not had an opportunity to examine them since their erection. These saddles should be changed, to provide lubricated roller bearings provided with hard steel bearing plates, properly housed.

The next, the Henderson bridge, has high-steel rollers between high-steel bearing plates, built at the writer's suggestion, which were kept well lubricated. Eight 250-ft. spans, however, have cast-iron bed-plates (pedestals), steel rollers and wrought-iron bases of the truss pedestals and were the design of the Chief Engineer alone. Six of these 250-ft. trusses are on an up-grade to the movable end (expansion end) of the 522-ft. channel-span, while the other two 250-ft. spans are horizontal and east of the channel-span.

None of these 250-ft. spans move at their free ends under any loads or temperature changes, as the rollers press deeply into the cast-iron bases, although they were well



Resolution of a Common Example of the Prismoid Into Simple Geometrical Components.

lubricated. The reason of the lack of motion is found in the very high, thin and flexible Indiana limestone piers carried by limestone foundations and sub-piers of the same material. These piers, from about 100 to 175 ft. high, are so flexible that they oscillate even under wind stresses of the six west 250-ft. trusses.

Moreover, as soon as a rapidly moving passenger train has crossed two 250-ft. spans at the west end on the heavy grade moving eastwardly, the west channel pier is bent eastwardly under the very sensitively moving roller beds of the 522-ft. channel span, until it has moved ¼-in. when the engine pulling the train has entered the channel span about 100 ft. From this moment all of the piers carrying the six 250-ft. spans slowly recede until the train has entirely left them, and is on the channel span. Heavy freight trains with one engine pulling and another pushing cause the bridge to shove all the piers eastwardly. As the writer remembers it, the 522-ft. channel span weighs rather more than 880 tons and instantly a train enters upon it from either end of the span the pedestals begin to dance sensitively forward and back, until the bottom chord of the bridge has expanded under the load of one passenger train about 3-16-in. (Exact figures are in my note-books and will be produced when time is available.)

This difference in behavior of the channel and approach spans at their expansion ends is most striking as exemplifying the difference in a properly designed lubricated steel bearing and others on cast-iron bearings.

At the writer's suggestion it was intended to box in all expansion bearings of the Henderson bridge with oilcloth after lubricating the rollers well, and thus to avoid clogging by sand and corrosion due to water, snow and ice. The writer does not know whether this has been carried out.

The most perfect expansion bearings are those under the new cables of the Cincinnati-Covington bridge. These consist of properly connected and guided steel roller-nests between steel plates in a bed of vaseline, held in place by a tight frame of guard angles and protected by a waterproof covering hood to keep all dust and hygroscopic depositions out of them.

This is the only kind of an expansion bearing which should be used under the free end of any kind of a bridge, as well as under the revolving tables of swing bridges. Anything short of this is an absurdity and perfectly useless. A bridge moves once (or but a limited number of times) in every day due to temperature changes; it moves considerably more, and every time when a train passes over it, due to variation of stress.

A "flat" bearing, as proposed by Mr. Rice, is a monstrosity, and can never act properly, as the lubricant will be forced out very rapidly, due to elastic flexure and distortion of the plate under irregular stress produced by vertical pressure of the end pin, causing the edges of the proposed square plate to turn upward.

Friction of rollers is well known under known conditions and loads, with many kinds of lubrication.

The friction between flat surfaces has not been determined and under conditions as proposed may be infinite as the metal will cut at the center of pressure.

All pins of pin-connected trusses should be lubricated to avoid cutting, as under loads there is actual motion of some parts on every pin. If this is not done rings will be worn on pins. All pins of truss bridges show such rings due to wear.

The writer has seen grooves worn in pins of the old Prime Street Viaduct (Penn. R. R., Philadelphia) after its removal—⅜-in. deep in 3½-in. pins.

Only a mechanical engineer who considers all conditions and is familiar with all properties of materials can properly design a pin-connected truss—which is a machine, subjected to small and slow motions. None of the roller beds designed by the late Geo. S. Morison and other engineers, which have come to the notice of the writer, act properly. Most of them are stuck by elastic distortion or due to corrosion.

Gus. C. Henning.

36 Gold St., New York City, April 27, 1905.

Sir: In your editorial on the use of rollers for the end supports of bridge spans you have opened up a subject whose full discussion will be of interest, and in connection with which I would make the following suggestions:

The changes in length from temperature are very gradual and no appreciable change can take place in the very short period a train is on the bridge. With the dead load only acting and with your coefficient of friction of 40% the maximum temperature stress in a chord member will only be 1-10 the dead weight of the structure. If, as is probable, the coefficient of friction for non-corrosive, lubricated or partially lubricated surfaces will drop to 10% or less, the stress in the chord will be but 1-40 the dead weight of the structure.

The change in the length of a supported chord due to the live load coming on will be opposed in a measure by the sliding surfaces and the stress in the chord thereby reduced.

As regards the forces acting on the masonry, the stresses from temperature will in the case of all ordinary spans be far below the stresses imposed by traction or the application of brakes, and masonry capable of sustaining the traction forces will be amply good for all stresses due to the sliding bearings proposed by Mr. Rice.

Yours very truly,

F. P. Shearwood.

Dominion Bridge Co., Montreal, P. Q., May 3, 1905.

A Comparison Between Plain and Distorted Bars for Reinforcing Concrete.

Sir: A paper was presented March 15 before the Western Society of Engineers, by T. L. Condron on "The Strength of Reinforced Concrete," comparing recent tests on various types of reinforcement with and without mechanical bond. I submit herewith Figs. 10 and 12 (see Figs. 1 and 2 respectively), taken from his paper without alteration, summarizing the tests on Johnson corrugated bars and on plain bars. Mr. Condron uses the full line in these diagrams to represent the ultimate strength M/bd^2 for a percentage of reinforcement P for the beam reinforced with Johnson corrugated bars, and the dotted line similarly for beams reinforced with smooth bars. The conclusion drawn by Mr. Condron is that the line representing the Johnson corrugated bars shows a strength of 64% higher than the line representing the smooth bars, for any given percentage of reinforcement.

Mr. Condron fails to point the one conclusion that is of paramount importance, that is as to strength based on cost. Strength on a basis of percentage of steel means nothing in a comparison, if one kind of steel costs twice as much as the other. To make the comparison on a basis of prices at Indianapolis, I have rearranged the test results and the lines, on a basis of cost of steel, in Fig. 3. Note that for a given cost of reinforcement, the strength of the beam with Johnson corrugated bar is less than with plain bar reinforcement.

The cost in Fig. 3 was estimated as follows: We last year purchased Johnson corrugated bars in car load lots f. o. b. Indianapolis at 2.45½ cts. per lb. for ¾-inch bars. We were at the same time buying plain round ¾-in. steel at 1.45½ cts. f. o. b. Indianapolis. Multiplying the percentage of steel in each test by the cost of the kind of steel, the results are as shown in Fig. 3. The strength curves for the beams compared as to cost of reinforcement are, $M/bd^2 = 183\,C + 55$ for Johnson cor-

rugated bars, and $M/bd^2 = 190\ C + 55$ for smooth rods, where C represents cost times reinforcement percentage. Thus, based on prices at Indianapolis in 1904, the smooth rods produce 4% greater strength than the Johnson corrugated bars as a reinforcement for beams. In the above comparison, moreover, I have not taken into account the additional weight of the Johnson bars due to the lugs which increase the weight without increasing the percentage of reinforcing area. This would give very nearly an additional 10% in favor of the smooth bars.

The cost is, however, so nearly the same for the two types of bars that other qualities should be taken into account. The diagrams Figs. 1 and 2 show that smooth bars give more uniformly reliable results than corrugated bars, the results of the tests being more uniformly consistent. Mr. Condron says of the Johnson corrugated bar tests:

80% are above the formula, 20% are below the formula, 8% are under 10% below the formula, the lowest is 22% below the formula.

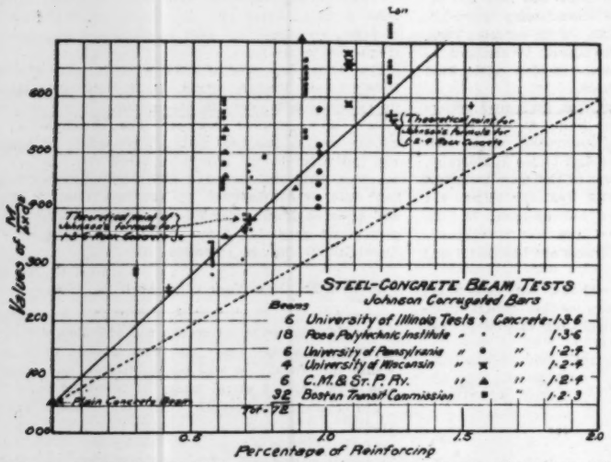

Values of M/bd²
Percentage of Reinforcing
Steel-Concrete Beam Tests
Johnson Corrugated Bars
Beams
6 University of Illinois Tests + Concrete-1-3-6
18 Rose Polytechnic Institute " " " 1-3-6
6 University of Pennsylvania " " " 1-2-4
4 University of Wisconsin " " " 1-2-4
6 C.M.& St.P.Ry. " " " 1-2-4
32 Boston Transit Commission " " 1-2-3
Plain Concrete Beam

FIG. 1. DIAGRAM SHOWING STRENGTH OF BEAMS REINFORCED BY CORRUGATED BARS.

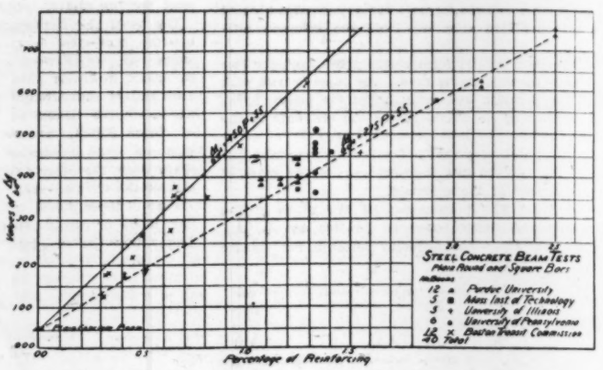


FIG. 2. DIAGRAM SHOWING STRENGTH OF BEAMS REINFORCED BY PLAIN BARS.

I would add similarly for the smooth bar tests, 75% are above the formula, 25% are below the formula, 2½% are under 10% below the formula, the lowest is 12% below the formula.

Johnson bars are of high elastic limit, while the plain bars in the above tests are of low elastic limit, oviously the safer kind of steel to use for impact loads. The argument advanced for corrugated bars that they will not slip and that smooth bars will slip is shown to be imaginary by the results of the above comparison; the smooth bars actually showing higher strength for same cost for static loads. What the comparison between these two types of bars would be under impact loads, as regards slipping, still remains to be proved, but the chance that the Johnson corrugated bars would prove superior is compensated to some extent by the assurance that the low tension steel of the smooth bars would be the safer. The argument advanced by some against smooth rods that as they stretch under tension their diameters contract, thus pulling the surface away from the concrete, is refuted by the above comparison. Moreover, such a contention is far-fetched on its face, for the diameter of a steel rod will contract as the square-root of the increase in length; and for a coefficient of elasticity of 30,000,000 say, a rod subjected to a stress of 40,000 lbs., or practically at its elastic limit, will contract but one five hundred thousandth (1/500,000) of its diameter, which I believe to be a negligible quantity.

The advantages of the smooth bars are that they are readily procurable in the market at any time and place. We have frequently placed orders for Johnson corrugated bars, and have received the reply that bars would be shipped in ten days. That ten-day delay, added to the two weeks required for shipment from Tonawanda, N. Y., to Indianapolis, is not a delay that can be viewed with complacency when smooth steel bars are available at Indianapolis on demand.

I am not opposed to patented bars. We ourselves are builders of patented bridges, because we believe them to be cheaper and better than other types, and the Johnson bars are as readily applicable to our construction as any other reinforcement except as to the objections above noted. I realize fully that Johnson corrugated bars have helped to popularize reinforced concrete work, because they appeal to a class of men who cannot believe that smooth steel rods will not slip, with all of European practice to the contrary notwithstanding. I have always found smooth steel rods preferable to any mechanical bond device for reinforcement, and Mr. Condron's comparisons have confirmed me in my opinions and given me reasons on which to base such opinions.

I wish to commend the promoters of Johnson corrugated bars also for the honesty of their advertisements. In their regularly published advertisement in your advertising columns they state that corrugated bars "Give 20 to 50% more efficiency than any other mechanical bond bar on the market," which is undoubtedly true since it does not include smooth bars, and the tests do show generally higher results than for other types of patented bars. The argument has recently been advanced by the advocates of the Kahn bar that the above tests are not conclusive for their bar, since the greatest efficiency of the Kahn bar is developed in shear. But obviously it is of little importance what the strength of a beam is in shear, if a concentrated load at its weakest point will not develop its full strength in shear before failure.

One other objection we find to the high tension Johnson bar is the difficulty of welding or otherwise extending the effective length of the bars. It is argued that connections may be made by overlapping the ends of the bars 3 or 4 ft., and in this connection I wish to show a photograph, Fig. 4, which, although a view of a collapsed Johnson bar bridge is in no wise a reflection on that type of reinforcement except as showing that a lap of 4 ft. was not effective.

The bridge was a 34-ft. span concrete girder, and was properly designed, with Johnson corrugated bars as reinforcement, but was not so erected by the contractor, who was inexperienced in this class of work. Note for example that he placed half of the steel at the neutral axis of the girder, than which nothing could better illustrate his failure to comprehend the construction.

The bearing of this example on the point under discussion, however, is that the steel bars were ordered in two lengths to span the opening, which being of 34-ft. span called for a bar too long to be shipped on one car. The contractor lapped the bars about 4 ft. at the middle of the span, as may be clearly seen in the photograph, and the junction failed to develop the full strength of the reinforcement, the girder falling when the forms were removed.

Very truly yours,

Daniel B. Luten,
Pres. National Bridge Co.

Indianapolis, Ind., April 7, 1905.

(In accordance with our usual practice, a proof of the above letter was submitted to Mr. Condron for examination and the privilege of reply. Mr. Condron has sent us the following reply to Mr. Luten's statements.—Ed.)

Sir: The writer has read with interest the letter of Mr. Luten on the relative efficiency of plain and corrugated bars for reinforcing concrete. In the confusion of moving both his office and home the proof of Mr. Luten's letter which you sent the writer has been lost, so he is obliged to comment upon the same without having it before him. He wishes to correct the impression of the author regarding the writer's paper before the Western Society of Engineers on the "Strength of Reinforced Concrete." That paper was simply a compilation and presentation of results of over two hundred tests at various engineering schools and railroad laboratories. It was not an argument for or against any kind of bar. If in these tests any particular bar made the best average showing it was proper to state the fact and base general conclusions thereon. For the benefit of those of your readers who have not seen that paper the writer begs to insert here three tables from his paper, as these give in very condensed form the entire matter.

TABLE I.—Elastic Limits of Reinforcing Bars Used.

	Pounds per Square Inch. Plain.	Corrugated
Purdue University	36,000	——
Mass. Inst. of Tech.	Not reptd.	——
Rose Pol. Inst.	——	60,000
University of Illinois	32,000-35,000	55,000-60,000
University of Wis.	75,000	59,000
University of Penn.	40,500	67,800
Boston Transit Com.	35,000-45,000	60,000
C., M. & St. P. Ry.	——	60,000

Table I. gives the reported elastic limits for the bars used. Table II. has been rearranged and condensed by the writer. In explanation, the actual ultimate bending moment in inch-pounds, M, was computed from the weight of the beam and the ultimate applied load for each test. This moment was divided by bd^2, where b is the breadth of the beam, and d the depth, to the plane of the reinforcing. All of the test results were plotted on diagrams using the value of $M \div bd^2$ as ordinates and values of P (the percentage of reinforcing) as abscissas. The study of these diagrams led the writer to offer as a general straight line formula for the strength of reinforced concrete beams $M \div bd^2 = mP + n$. H drew straight lines on the diagrams making $n = 55$, and for plain bars, $m = 275$, while for corrugated bars $m = 450$.

In Table II. the average values of m for each kind of bars in every series of tests are given. From this table it will be seen that in the series of tests at the Universities of Illinois and Pennsylvania and by the Boston Transit Commission, similar beams with both plain and corrugated bars were tested. The results show that the beams with corrugated bars were stronger by 59%, 48% and 46%, respectively, or an average of 51% in favor of the corrugated bars. If this were the whole story then it might be said that corrugated bars were worth 50% more than plain structural bars as a reinforcing material. However, these tests were all made without the influence and effect of impact or vibration on the beams tested, and it is rather surprising that the beams with corrugated bars developed greater strength, as shown by Table III., than the ratio between the elastic strengths of the different bars.

TABLE III.—Comparison of Average Elastic Limit of Bars and Relative Strength of Beams.

Kind of Bars.	From Table I. Elastic limits of bars.	From Table II. Strength of beams.
Plain	38,000 = 100%	333 = 100%
Special plain	75,000 = 197%	445 = 134%
Corrugated	60,000 = 158%	538 = 162%

The important claim made for corrugated bars has been that impact and vibrations will not affect their bond to the concrete.

The cost of reinforcing bars is not simply the cost of those bars at the mill, or even on cars at the nearest point

Table II.—Comparison of the Actual Average Ultimate Strengths of Beams Tested with the Theoretical Ultimate Strength Determined for Each Beam, by the Formula $(M \div bd - 55) \div P = M$.

Kind of Bars used. Aver. Elas. Limits of Bars. Number of Tests and M.	Plain —37,700— No.	M.	Special Plain —75,000— No.	M.	Corrugated —60,100— No.	M.	Strength of Concrete in Compression. Lbs. per sq in.
Univ. of Illinois	5	274	....	....	6	436	2030
Mass. Inst. Technology	5	283	....	....	....	....	Not reported
Purdue University	12	288*	....	....	....	....	2730
Univ. of Pennsylvania	6	292	....	....	6	432	1710
Rose Polytechnic Inst.	....	....	....	....	18	477	Not reported
Univ. of Wisconsin	....	....	19	445	4	549	2913
C. M. & St. P. Ry.	....	....	....	....	6	630	Not reported
Boston Transit Com.	12	441	....	....	32	643†	3930
Number of tests and general averages	40	333	19	....	72	558	.....

* Two tests of cinder concrete omitted.
† Neglecting twelve tests with bars in compression as well as tension.

the job. In every case there is the additional cost of handling and putting into the concrete, and generally there is an expense for cartage which alone will be several dollars per ton. The cost of handling, cartage and bending will range from $4 to $15 or more per ton, depending upon length of haul and amount of bending to be done. In the case of plain bars it is customary to bend up the ends of the bars, a confession that the bond is insufficient. Taking the present cost of plain bars at Indianapolis as 1.65 cts. per lb. and adding $8 per ton or 0.4 ct. per lb. for handling and bending makes the plain bars cost 2.05 cts. per lb. According to these tests corrugated bars are worth 50% more than plain, or the plain would be worth 3.08 cts. per lb. in the work at Indianapolis, or allowing the same for handling, etc., they would be at a stand off for cost at 2.65 cts. per lb. f. o. b. cars Indianapolis. In fact the cost of field work will be less with corrugated than with plain bars, and therefore the facts are that generally it will be a stand off so far as cost of bars is concerned when corrugated bars cost 65 to 70% more than plain bars f. o. b. cars at the nearest point to the job. If allowance is made for the greater safety due to the positive mechanical bond of the corrugated bars they will be found economical to use even when they cost on cars double what plain bars cost.

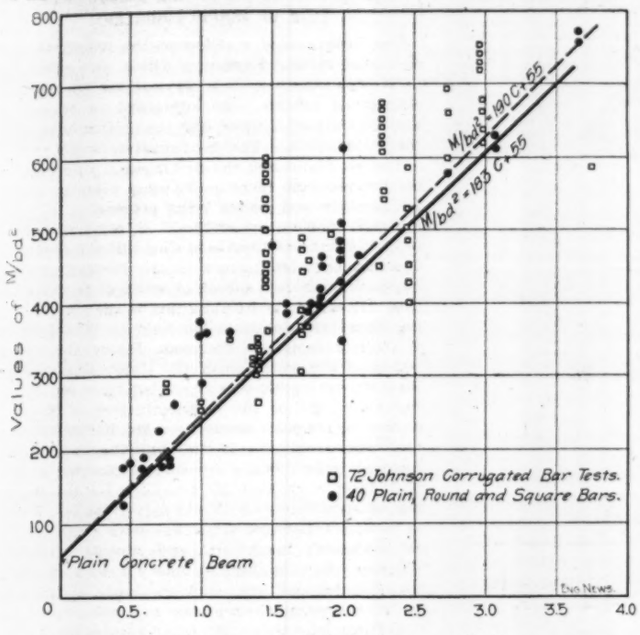


FIG. 3. DIAGRAM COMPARING STRENGTH OF BEAMS REINFORCED BY CORRUGATED BARS AND PLAIN BARS ON BASIS OF COST OF STEEL.

Moreover, since the ultimate strength of reinforced concrete beams is practically reached when the bars are stressed to their elastic limit, an allowable stress of 10,000 lbs. is within nearly one-third of the ultimate strength of the beam when ordinary plain steel bars are used. An allowable stress of 15,000 lbs. in corrugated bars is only one-fourth of the average elastic limit of those bars as furnished.

With regard to plain bars of high elastic strength it is instructive to note the results of the tests with very high elastic limit plain bars at the University of Wisconsin. The bars used had an elastic limit 25% greater than that of the corrugated bars, but the average strength of the beams reinforced with these high elastic plain bars was 34% below the average strength of the beams reinforced with corrugated bars in the same series of tests.

Mr. A. L. Johnson, the patentee of corrugated bars has made the following statements regarding the bond between steel and concrete:

There are three influences affecting the adhesion of cement to a metal surface, as follows:

1°. Breuillié, at La Chaînette, reported some investigations in Annals des Ponts et Chaussées for 1900, which showed that soaking in water for nine months reduced the adhesion of concrete to metal from one-half to two-thirds.

2°. Prof. Schule, who now occupies the position at Zürich formerly held by Prof. Bauschinger, reported at the International Engineering Congress at St. Louis in October, 1904, that when the reinforcing bars were stressed, even though inside the elastic limit, the cross-section was slightly reduced. Inasmuch as the adhesion consists, simply, in the entering by the cement particles into microscopical pores on the surface of the metal, any shrinkage of the cross section of the metal, however slight, was sufficient to materially affect the value of this adhesion.

3°. In our experience we have had cases of rupture of the adhesion with plain bars after eight years' use, where the structure was not wet, nor did the stress in the bars ordinarily amount to much, this failure being due entirely to vibrations and shocks.

That foreign engineers, who have been mainly responsible for the use of plain bars for concrete reinforcement, are coming to realize the unreliability of adhesion alone, is indicated in many ways, chief of which is that the specifications prepared about a year ago, covering all this kind of work in the German Empire, state that "the bond shall, so far as possible, be of a mechanical nature." Up to that time there had been practically nothing used but plain bars. Further, it is noticeable that most of the French companies are now turning up their rods at the end or using some similar device, though what advantage is to be gained by turning up a three-quarter inch rod sixteen feet long an inch or two at the end, it is hard to realize.

Foreign engineers, as a matter of fact, have not had the experience that we have. Their beam work, in which alone these weaknesses develop, dates back only eight or nine years, while in the United States we have been building beams almost continuously since 1875. As it has taken eight years for this weakness to develop in some of our own work, and as abroad they first used mortar instead of concrete, which gives a stronger adhesion, it may be said that the time is only just arriving when we might expect them to discover the necessity of using other means of obtaining a reliable bond. And as before stated, these expectations are now realized.

With regard to the photograph of the bridge which collapsed when the forms were taken out, it is certainly a fortunate thing that it did so, for if the concrete had been somewhat better it might have held as a plain masonry beam long enough to have allowed a live load to get on the bridge, when it would have fallen. The photograph tells the whole story. Half of the bars are at the neutral plane and offered no resistance, the other half are at least 6 ins. from the bottom of the beam. The concrete therefore must have been seriously cracked on the bottom before the bars were stressed at all and therefore in no condition to transmit tensile or shearing stress from one bar to another at the splice. The stress in the bars, had the structure held together would have been approximately 20,000 lbs. per sq. in. simply from dead load alone. Mr. Luten does not say how the structure was designed, nor what was the quality of the concrete, but the writer has been informed that there was no trouble in breaking up the concrete and taking out the bars after the failure, which shows that the concrete was either very green or very poor. In fact this photograph illustrates the most striking example of dangerous construction the writer has ever seen and emphasizes the necessity of honest and intelligent designing superintendence, and inspection of reinforced concrete work. As Mr. Luten does not describe the original design for this structure any criticism of that would be out of place here, but as executed the structure deserves the strongest condemnation both as to superintendence and lack of inspection, unless it was designed as built. In that case the design was criminal, for it might have been a death trap. This structure does not prove anything with regard to corrugated bars, but the writer trusts that the published photograph will serve a good purpose by calling attention to the dangers of ignorance and carelessness in designing and building reinforced concrete work. Reinforced concrete should never be built except under intelligent and constant supervision and from carefully and completely made plans which show exactly how the metal is to be placed. Such plans become the only record of the construction that can be had, for the finished structure does not disclose how it is reinforced.

Yours respectfully, T. L. Condron.

Chicago, Ill., May 1, 1905.

THE LAYING OUT OF CITY LOTS BOUNDED BY CURVED AND STRAIGHT LINES.

By Ernest McCullough,* M. W. S. E.

The writer must offer an apology to some engineers for presenting this article. He deems it a necessary one, however, for several reasons:

1st. He has many times had occasion to retrace surveys of subdivisions having lots with curved boundaries that could not be made to check. As the rectangular work was fairly good, he was forced to believe that certain lots were plotted on a large scale and the dimensions scaled.

2d. He caught a surveyor getting dimensions in this manner, and earned a few dollars showing him how to do it.

3d. Several times he found surveyors running intersections in the field and making no calculations.

4th. Of a certain tract of land he made a topographical survey, and on the map drawn by his assistant he laid out all the streets and alleys by scaling. Being called away for a few days he gave the assistant orders to calculate all dimensions. Upon his return he found nothing done, and a young fellow ready to quit because he did not know how to start.

Looking over some old notes a few days ago, he found the sketches and calculations for subdivision made several years ago, and has copied enough to illustrate methods.

The blocks were 400 ft. long and 200 ft. wide without alleys; streets 60 ft. wide; lots 25 × 100 ft. All the above dimensions were fixed for the owner by the real estate agent before any surveys were made. The writer had instructions to lay out the ground on this plan with rectangular lots, and keep all street grades down to 10%. Whenever the slope of the ground did not permit such a grade or a lighter one, he could deflect the roads and do it with curves. Along the brow of a steep hill he was to run a curved avenue, and what the lots lacked in depth could be made up in width. Under this plan the owner would have practically 11.6 lots to the acre. The land was worth $35 per acre, and each lot would sell for not less than $50. In this particular case the hopes of the owner and agent were fully realized, many lots selling for more than $100.

A stadia survey was made of the steep hillside and of all parts where the maximum street grade might be exceeded. This was platted on a scale of 100 ft. to an inch with 5-ft. contours. The boundaries of the tract were laid on the map, and the regular subdivision as planned drawn on it in lead pencil. Fine red ink lines, dividing the map into 100-ft. squares were next carefully drawn. They were used for scaling coordinates to check the calculations.

The southwest corner of Block 27 was taken as the point of origin of latitude and departure points, for the curved road commenced in that block. The hill road was stepped off on the contours to the proper grade and curves drawn as shown.

It will be readily seen how the latitude and departure distances were obtained for all the lot corners up to the B. C. on the front of lot 22 in Block 27. The radius being normal to front of the lots 2, 10, 14, 18 and half of 22, it was easy to calculate the latitude and departure for the center of the circle. Likewise it was easy to calculate the point of reverse curve and the E. C. of the following curve. The central angles were measured with a protractor, but, if the calculated distances varied more than 5 ft. from the scaled distances, the angle was changed and the distances recalculated. This was a paper location to be transferred exactly to the ground, as a map was to be completed and filed before a stake was set. The owner was anxious to sell quickly.

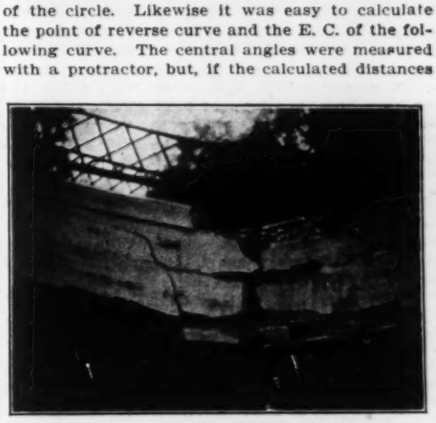


Fig. 4. View of Failure of Reinforced-Concrete Girder Showing Failure of Lapped Bars to Hold.

The problem was to get the lengths between lots of the lines terminated by the sides of the curved roads and also the frontage length, as the lawyer insisted that "Lot 22 in Block 27, etc.," was not a

*Chicago, Ill.

sufficient description, and all dimensions had to be written in deeds.

Taking the line between lots 22 and 26, the south end has Lat. 100 and Dep. 300. The center of the curve has Lat. 119.93 and Dep. 306.11. Taking a point due west on the lot line we get Lat. 119.93 and Dep. 300. This gives a right-angled triangle having an altitude of 6.11 ft. and a hypotenuse of 100 (the radius of the curve). The base of this triangle is 99.81, which added to 19.93 gives length of line between the lots as being 119.74 ft.; Lat., 219.74; Dep., 300.

The angle at the base is 3° 31', hence the bearing of the hypotenuse is S. 3° 31' E. and the difference of angle between radius to B. C. and radius to end of lot is 14° 36'. The length of the circumference of the circle is 628.32 ft.

360° : 14° 36' :: 628.32 : X;

therefore the length of the curved portion of the front of lot 22 is 25.49 ft.

Similarly, taking a point on the line between lots 26 and 30 due east of the center of the circle, a point is obtained having Lat. 119.93 and Dep. 350. This gives a right-angled triangle with altitude of 43.89 ft. and hypotenuse of 100 ft. (= radius). The base is 89.85 ft.; added to 19.93 ft. gives a total length of 109.78 ft. and the corner on the avenue between the lots has Lat. 209.78 and Dep. 350.0.

The angle at the base is 26° 02', hence the bearing from the center of the curve to the N. E. corner of lot 26 is N. 26° 02' E. The bearing to the other corner we found to be N. 3° 31' W., so the included angle is 29° 33'.

360° : 29° 33' :: 628.32 : X;

therefore, the length of the curved front of lot 26 is 51.58 ft.

The included angle between radii to corner between lots 26 and 30 and the point of reversed curve is 14° 51'.

360° : 14° 51' :: 628.32 : X;

therefore, the length of the curved front of lot 30 from the corner to P. R. C. is 25.92 ft.

To check:

Curved front lot 22 =	25.49 ft.
" " " 26 =	51.58 "
" " " 30 =	25.92 "
Total length curve	102.99 ft.

Total included angle is 59° 360° : 59° :: 628.32 : 102.97 ft. check.

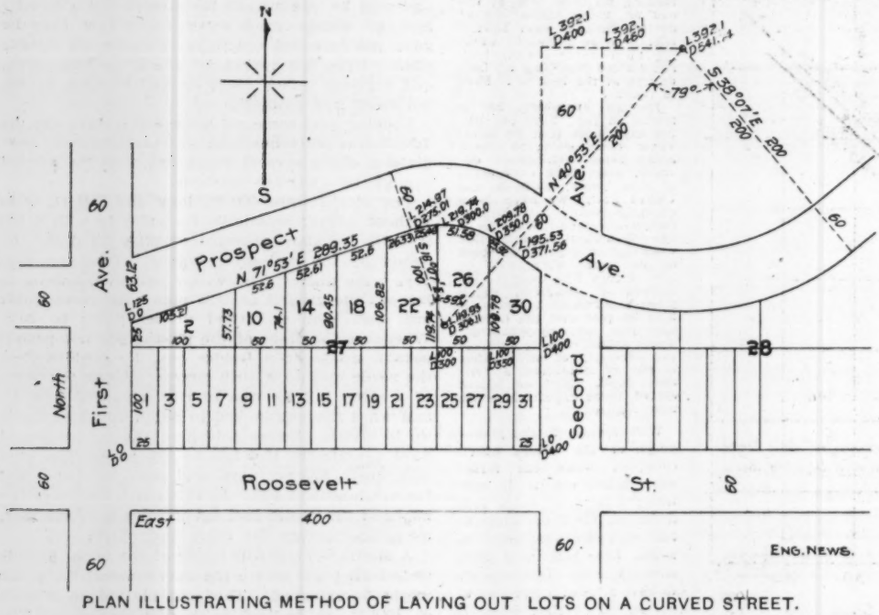
The lines drawn on the diagram indicate the method of procedure for the next curve.

Care must be taken to check all calculations by measurement.

In recording the map the dimensions of the lots as found are placed on it, and the radii of all curves drawn to an intersection with the length of radius marked, together with central angle. It would be a great help to future engineers if all Lat. and Dep. measurements were tabulated on the map.

The foregoing is the practice usually followed by the writer. A stadia survey of the tract to be subdivided is first made and the subdivision plotted on the contour map. Everything is carefully calculated and the lines afterwards run in on the ground.

It has one great advantage when time presses. A carefully measured base line can be run with stakes set at certain intervals and a number of parties can be put to work at one time, each with complete notes and maps to work from.



PLAN ILLUSTRATING METHOD OF LAYING OUT LOTS ON A CURVED STREET.

A NOVEL DUMPING WAGON.

The accompanying photograph shows a contractor's dump wagon, which may also be used as a spreader wagon. It will be seen that it has two doors crosswise of the box, and that they are lowered simultaneously. If it is desired to dump the load all in one spot, the driver places his foot on a dumping lever, which withdraws support from a holding pawl, and permits the doors to drop. If, on the other hand, it is desired to spread the load, or to let the load down gently, the driver jams down the foot lever and simultaneously a brake is applied to the hand wheel. By easing off on this brake he can spread the load as desired. For dumping a load of bricks without breaking them, and for spreading earth in embankments, and the like, this wagon is especially serviceable. We wish also to call attention to the fact that road builders will find it a useful tool for spreading macadam or gravel on the road, as well as for spreading earth fills.

By placing the doors crosswise, it has been possible to widen the box and shorten the wheelbase. The distance between axles is just 8 ft., yet the wagon is no higher than others of the same capacity. A short wheelbase is of advantage where a wagon must be turned on a narrow embankment, or in a confined place. It is claimed, moreover, that the load is well distributed on both axles.

At the time of dumping, the sliding of the load off the dumping doors pushes the wagon forward, and aids in preventing any stalling of the [illegible] on the soft dump.

The wagon is manufactured in several sizes by the Moore Mfg. Co., of Syracuse, N. Y.

A NOVEL DUMPING WAGON.

WASHINGTON MEETING OF THE AMERICAN INSTITUTE OF MINING ENGINEERS.

The 35th annual meeting of the American Institute of Mining Engineers which was commenced in New York City, Feb. 21 last for the [illegible] election of officers, was adjourned to Washington, D. C., and a three day convention was held there last week. The headquarters were at the Arlington Hotel and the first session was held in the banquet hall there on Tuesday evening, about 70 members and guests being present.

Mr. S. F. Emmons of the U. S. Geological Survey, Chairman of the Local Committee introduced Commissioner McFarland, of the District of Columbia who made a speech of welcome to the visitors. It is noteworthy that this is the fifth meeting which the Institute has held at Washington.

After a reply by President James Gayley, a report of the condition of the Union Engineering Building enterprise was requested from Mr. Chas. Kirchhoff, one of the representatives of the Institute on the joint committee. Mr. Kirchhoff said that the architects of the building, who were selected some months ago had progressed so far with their work that the contracts for the building construction were about ready to be let. There is to be a cellar and sub-cellar with room for all the necessary machinery, and storage of bound volumes, etc. On the first floor will be a spacious lobby, entrances, etc., and the large auditorium which will occupy two stories and will seat about 1,400 people. Above all smaller meeting rooms, some of which are conveniently arranged for social functions.

Above are six office floors, one for each of the three societies and others which may be occupied by other engineering organizations, and above that is the library.

The Secretary Dr. R. W. Raymond reminded the members that they were meeting for the first time as an incorporated society. In order to take part in holding the valuable real estate included in Mr Carnegie's gift it was necessary that the society be incorporated. Under the old plan of organization the property of the society belonged legally to all of the members now numbering nearly 4,000 and it was legally possible for the widow of a deceased member or the creditor of a bankrupt member to sue the society and demand that the share of that member be delivered to them. Safety lay in the fact that the society had not enough property to make such an operation profitable; but now that the society is to be a custodian of a great property incorporation was a necessary safeguard. After unraveling much legal red tape the incorporation was properly effected.

The remainder of the evening was spent and well spent in listening to the reading of biographical sketches of two distinguished members of the profession recently deceased, viz., Sir. Lowthian Bell and Dr. Thos. M. Drown.

Dr. Henry M. Howe was the biographer of Sir

owthian and his account of the life work of the eat metallurgist was an admirable one, well orthy of permanent record in the "Transactions."

Dr. Droun's biograph was prepared by Secretary Raymond and was likewise a worthy record f a man who as a chemist and a worker in the ield of technical education holds a high place. His long service as Secretary of the Institute n its earlier years made it particularly appropriate that an extended memorial of his life and orks should be made in its "Transactions."

Forty-five papers have been offered to the Institute for presentation either at the present meeting or the one to be held in Victoria, B. C., in July. Of these 11 are on blast-furnace practice, 8 on coal, coke and gas, 11 on general mining and metallurgy and 7 on ore deposits.

At the meeting on Wednesday morning the papers taken up were one by J. E. Johnson, Jr., of Longdale, Va., on the Blast Furnace, and one on the Production and Characteristics of Wrought Iron, by Mr. Jas. P. Roe, of Pittstown, Pa. Mr. Roe is the inventor of a mechanical puddling system which was described in Engineering News some months ago. The paper started a long and interesting discussion on the characteristics of wrought iron and steel.

This discussion was continued at the session of the afternoon which was held at the National Museum. One matter to which much attention was given was the relative resistance to corrosion of wrought iron and steel. We shall hope to present a full report of this discussion later.

At the close of this discussion Prof. Geo. P. Merrill explained the manner in which the geological specimens are arrayed in the National Museum and then escorted a party of visitors about the museum. In the evening a visit was paid to the Library Congress.

On Thursday morning, May 5, the concluding session for technical papers was held at the Cosmos Club, where Mr. Geo. T. Wickes, of Covington, Va., described a machine for driving coke from beehive ovens. This was followed by some of the papers on ore deposits.

In the afternoon a party of 150 or more enjoyed an excursion by boat to the Indian Head proving grounds where the operation of testing guns and armor plate was exhibited to the visitors. In the evening many of the members were received with the delegates to the Railway Congress at the Corcoran Art Gallery.

DROUGHT IN THE OHIO DRAINAGE BASIN DURING THE YEAR 1904.

By E. C. Murphy,* M. Am. Soc. C. E.

The recent quite severe drought in the Ohio drainage basin calls attention to the fact that not only in the arid West is there a shortage of rainfall and consequent water supply, but east of the Mississippi occasionally also, and brings prominently into view the necessity for abundant water storage. Fortunately, this drought came near the end of the growing season and did not cause a severe shortage of crops, but it has affected seriously manufacturing, railway and navigation interests in this basin.

From a study of the rainfall records at several places in this basin, obtained by the U. S. Weather Bureau, it is found that the annual precipitation varies from about 35 ins. to 45 ins., and has been below the normal for two years or longer. There was a deficiency in Cincinnati of 10.2 ins. in 1904, and an accumulated deficiency at that place of 39.7 ins. for the period 1901 to 1904. The deficiency was 12.1 ins. at Louisville, Ky., in 1903, and 16.8 ins. in 1904. The smallest monthly precipitation in 1904 was ¼-in.

The years 1835, 1871, 1895 and 1901 were also years of small precipitation in this basin. River stages along the Ohio are usually referred to the low water of 1895.

The U. S. Geological Survey has upwards of 30 gaging stations in this basin, and some of the data obtained at these stations during this drought will be of interest to engineers. Table II. gives the monthly run-off in second-feet per square mile at 20 of the stations for the seven months June to December, 1904; also the mean for these seven months. Table I. gives more detailed information.

It frequently happens that a considerable portion of the flow of a stream is held back for some days by a dam, so that the discharges given in Column 5 of Table I. do not necessarily show the minimum daily discharge, but a study of the results in Columns 5 and 7 will give a correct idea of the average minimum daily flow. It will be seen that the streams south of the Ohio not only have a larger minimum flow per square mile of drainage area, but their flow fluctuates less than those north of the river.

*Engineer, Hydrographic Branch, U. S. Geological Survey, Washington, D. C.

TABLE II.—Run-off per Square Mile of Streams in Ohio River Drainage Basin (1904)—Second Feet per Square Mile.

Stream	Place	Months, 1904						
		June	July	August	Sept.	Oct.	Nov.	Dec.	Mean
Licking River,	Pleasant Valley, Ohio	.721	1.310	.197	.180	.154	.145	.398	.437
Wabash River,	Logansport, Ind	1.940	.845	.128	.139	.124	.110	.345	.519
Tippecanoe River,	Delphi, Ind	.634	.660	.282	.318	.310	.236	....	.406
Olontangy River,	Columbus, Ohio	.360	1.220	.041	.053	.045	.038	.198	.294
Scioto River,	Columbus, Ohio	.231	1.380	.048	.029	.042	.046	.105	.269
Mahoning River,	Youngstown, Ohio	1.76	.324	.246	.073	.049	.084	.238	.396
White (East Br.) River,	Shoals, Ind	.485	.314	.132	.107	.089	.073	.190	.199
Youghiogheny River,	Friendsville, Md	1.19	.627	.183	.153	.207	.168	2.72	.747
New River,	Radford, Va	1.49	1.03	1.08	.520	.299	.492	.576	.784
New River,	Fayette, W. Va	1.34	.828	.604	.274	.173	.239	.427	.555
Greenbrier River,	Alderson, W. Va	.988	.262	.105	.084	.045	.062	.307	.262
French Broad River,	Oldtown, Tenn	1.13	.748	1.08	.648	.303	.543	.792	.749
Tennessee River,	Knoxville, Tenn	.725	.678	.703	.362	.219	.317	.702	.529
Pigeon River,	Newport, Tenn	.997	.913	.890	.519	.281	.420	.808	.690
Nolichucky River,	Greenville, Tenn	1.19	.847	.921	.521	.336	.535	.791	.784
So. Fk. Holstine River,	Bluff City, Tenn	.664	.622	.699	.331	.223	.351	.786	.525
Little Tennessee River,	Judson, N. C	1.47	1.07	1.60	.951	.444	.699	1.43	1.095
Tuckasagee River,	Bryson, N. C	1.42	1.12	1.39	.885	.579	.690	1.22	1.043
Hiwassee River,	Murphy, N. C	1.30	.927	1.40	.688	.429	.546	1.07	.909
" "	Reliance, Tenn	.991	.788	1.08	.530	.349	.476	1.09	.758

TABLE I.—Data on Minimum Flow of Streams in Ohio Drainage Basin (1904)—Discharge in Cubic Feet per Second.

Name of River	Place	Drainage area, sq. mi.	Discharge July 20 and Dec. 20 From	To	No. days discharge was — or less Days	Sec. ft.	Date From	To
Licking,	Pleasant Valley, Ohio	696	810	66	9	66	Nov. 27	Dec. 5
Olintangy,	Columbus, Ohio	520	104	5	9	5	Sept. 26	Oct. 4
Scioto,	" "	1,051	215	7	6	24	" 24	Sept. 29
Mahoning,	Youngstown	958	985	0a	10	23b	Oct. 1	Oct. 10
Wabash,	Logansport, Ind	3,163	1,118	280	26	350	Oct. 18	Nov. 13
Tippecanoe,	Delphi, Ind	1,890	1,200	291	10	335	Aug. 7	Aug. 16
White,	Shoals, Ind	4,900	1,330	215	63	360	Oct. 22	Dec. 23
Allegheny,	Kittanning, Pa	8,690	....	....	8	2,000	Sept. 19	Sept. 26
Kiskiminetas,	Salina, Pa	1,769	....	....	13	175	Sept. 24	Oct. 6
Blacklick, c,	Blacklick, Pa	403	....	....	10	45	Aug. 30	Sept. 8
Youghiogheny,	Confluence, Pa	392	....	....	8	35	Oct. 1	Oct. 8
Castleman,	" "	482	....	....	22	44	Sept. 22	Oct. 13
Laurel Hill, c,	" "	126	....	....	62	16	Oct. 14	Dec. 14
New,	Radford, Va	2,725	14,905	690	13	690	Oct. 13	Oct. 25
"	Fayette, W. Va	6,200	6,210	984	8	1,050	Oct. 6	Oct. 13
Greenbrier,	Alderson, W. Va	1,344	217	46	7	46	Sept. 30	Oct. 6
Cumberland,	Nashville, Tenn	....	4,630	1,060	9	1,160	" 24	" 2
Tennessee,	Knoxville, Tenn	8,990	13,710	1,750	20	1,930	Oct. 15	Nov. 3
"	Chattanooga, Tenn	....	....	....	13	4,980	" 21	" 2
French Broad,	Old Town, Tenn	1,737	2,955	400	29	535	" 4	" 2
Pigeon,	Newport, Tenn	655	1,660	160	23	180	" 11	" 2
Nolichucky,	Greenville, Tenn	1,099	2,043	320	15	355	" 13	Oct. 27
Little Tennessee,	Judson, N. C	675	3,280	275	20	275	" 13	Nov. 1
Tuckasagee,	Bryson, N. C	662	3,050	340	6	340	" 28	" 2
So. Fk. Holstine,	Bluff City, Tenn	828	1,140	150	26	190	" 9	" 3
Hiwassee,	Murphy, Tenn	410	3,230	150	26	190	" 9	" 3
"	Reliance, Tenn	1,180	3,780	380	8	380	" 19	Oct. 26

a Affected by dam.
b Average for 10 days.
c Creek.

AN ELEVATED WATER TANK at Ogden, Ia., failed on April 22. It appears that the tank was of wood and that the bonds or hoops gave way. The electric light station was damaged.

LARGE WATER-WORKS PUMPS are to be built at New Orleans and Pittsburg under contracts recently awarded. At New Orleans three 40,000,000-gallon centrifugal pumps, direct-connected to horizontal cross-compound Reynolds-Corliss engines, will lift water from the Mississippi River to settling basins, and four 30,000,000-gallon vertical triple expansion crank and fly-wheel pumping engines will repump the water after filtration. A 20,000,000-gallon centrifugal pump will also be built, and an electrical plant will be installed. The contract for all this work, and for the Pittsburg plant mentioned below, has been awarded to the Allis-Chalmers Co., of Milwaukee, Wis. At Pittsburg there will be four 35,000,000-gallon centrifugal pumps with a contract head of 45 ft. and two 30,000,000-gallon vertical compound crank and fly-wheel pumping engines under a 360-ft. contract head.

AN IMPROVED WATER SUPPLY FOR SPRINGFIELD, Mass., has been under consideration for a number of years. The various plans proposed have included the filtration or double filtration of the present Ludlow supply, for the prevention of trouble from algae growths, and the plans have also included an independent supply. A few days ago Mr. Allen Hazen, M. Am. Soc. C. E., 220 Broadway, New York City, reported strongly in favor of an independent supply from Little River. His plan embraces a 6,000,000,000-gallon reservoir 920 ft above tide, a diversion dam two miles further down the stream at an elevation of about 500 ft. above tide, a steel conduit 1,500 ft. long, a tunnel 4,800 ft. long, purification works at the end of the tunnel, two 36-in. supply mains each twelve miles long, and a distributing reservoir. Such works could be made to yield 30,000,000 gallons a day, but for the present 15,000,000 would suffice and the latter could be provided for $2,177,000, including land, water rights and a tunnel to double the supply. Postponing filtration for some years would lessen the estimate by about $350,000

A COMPRESSED AIR TRACTION PLANT working at the pressure of 1,000 lbs. per sq. in., is being built for the United States navy yard at Mare Island, Cal. A Norwalk Iron Works three-stage compressor, running at 140 r. p. m., geared from a 30-HP. Westinghouse induction motor running at 685 r. p. m., will furnish the air to a storage tank, from which the locomotive draws a supply sufficient to operate it for six hours. The locomotive, built by the H. K. Porter Co., of Pittsburg, Pa., is of 36-in. gage and can be run at a speed of 6 mi. per hr. The two cylinders are 6 ins. in diameter by 10 ins. in stroke; the engine can haul a train weighing 80 tons.

GLASS PAVING AND BUILDING BRICKS is the title of Consular Report No. 2241, Department of Commerce and Labor, Washington, D. C. In this report are given data on the manufacture and use of glass bricks in Europe. It appears that glass bricks made of old bottles, and the like, are quite extensively used. One factory reinforces its hollow glass bricks with woven wire. For pavement purposes glass bricks appear not to have been much of a success thus far, but for certain building purposes there seems to be a good field. Catalogs, which accompanied many of the reports from consular officers, are on file in the Bureau of Statistics, Department of Commerce and Labor.

THE METRIC SYSTEM IN MEXICO.—I have just returned from a two years' engagement as master mechanic in Mexico, and in all that time I saw no metric units used in mechanics. Railroads, mines, buildings, power plants, lumber mills, rolling mills, and, in fact, everything mechanical uses feet and inches. While iron is purchased by the pound, if it is imported from the United States it must be invoiced in kilograms to conform to custom-house requirements. A mining company's store clerk checks out such things by the pound. Even in the regular city stores one buys meters of cloth that is one yard wide, kilos of 3-in. nails, 1-in. iron, or 12-lb. rails. After a thousand years of that sort of use of the metric system the change back to the English system could be made in a day, as easily as was the change to the metric. The ordinary two-foot rule can be purchased in Mexico

with metric graduations on one side, but I found not the slightest use for these graduations. Firewood is purchased by the cord and *cargo*, and ore by the *cargo*. I wonder if the metric system is used in other so-called metric countries as it is in Mexico?—Mark R. Lamb, in "The Engineering and Mining Journal."

PERSONAL.

Mr. Henry L. Merker, formerly City Engineer of Belleville, Ill., is now Manager of the Enid Electric & Gas Co., of Enid, Okla.

Mr. Roswell D. Cooper has been appointed Assistant Engineer and Inspector of Public Works for the city of Little Falls, N. Y.

Mr. Wm. H. Arnold, C. E., has been appointed Superintendent of Floating Equipment of the Bush Terminal Co., Brooklyn, N. Y.

Mr. E. B. Darlington has been appointed Chief Engineer of the State Wagon Road Commission of Idaho, with headquarters at Boise.

Mr. Fred Giddings has been reappointed City Engineer of Atchison, Kan. With the exception of one year Mr. Giddings has been City Engineer since April, 1885.

Mr. G. A. Casseday has been appointed Bridge Engineer of the Great Northern Ry., and Mr. Samuel L. Bartlett, Architect, both with headquarters at St. Louis.

Mr. C. E. Drummond has been appointed Assistant Engineer of the Oregon Short Line R. R., and will have charge of the work of construction of the Malad Valley branch.

Mr. J. P. Hallihan has been appointed Chief Engineer and Assistant to the President of the Rio Grande, Sierra Madre & Pacific Ry. He will have his headquarters at El Paso, Tex.

Mr. W. J. Crocken has been reappointed City Engineer of East St. Louis, Ill., and Messrs. W. A. Thompson, Geo. H. Meck, and P. B. Leivey have been appointed Assistant Engineers.

The duties of Mr. Mason R. Strong, Bridge Engineer of the Erie R. R., have been extended to include buildings, and his title has been changed to Engineer of Bridges and Buildings.

Mr. H. L. Russell and Mr. E. French have formed a partnership for practice as Consulting and Supervising Civil Engineers, and have opened an office in the Moffat Building, Detroit, Mich.

Mr. John O. Potter has been appointed City Civil Engineer of Muncie, Ind., to succeed Mr. Fred. Crandall, who has resigned to accept a position in the Engineering Department of the Great Northern R. R.

Mr. Ira G. Hedrick, M. Am. Soc. C. E., of Waddell & Hedrick, Consulting Engineers, Kansas City, Mo., has had the degree of Doctor of Science conferred upon him by McGill University, Montreal, Canada.

Mr. R. E. Taft, Resident Engineer of the Great Northern Ry. at West Superior, Wis., has been appointed Engineer of Construction, with headquarters at St. Paul, Minn. He is succeeded as Resident Engineer by Mr. F. W. Walker.

Mr. Selden M. Witbeck, heretofore Assistant Engineer of the Des Moines Valley Division of the Rock Island lines, has been appointed Roadmaster of the Watertown Branch of the Dakota Division at Ellsworth, Minn.

Mr. R. Godeffroy has resigned his position with the Philadelphia Rapid Transit Co., and has opened an office in the Citizens' Trust Building, Paterson, N. J., for practice as a Civil and Consulting Engineer and Architect.

Mrs. Frances A. W. McIntosh, formerly Advertising Manager of the Standard Tool Co., Cleveland, O., is now connected with the Advertising Department of the Hill Publishing Co., publishers of "Power," 505 Pearl St., New York.

Mr. Albert S. Crane, M. Am. Soc. M. E., since 1902 Principal Assistant Engineer of the Sanitary District of Chicago, in charge of the design and construction of the 30,000-HP. water power plant on the Chicago Drainage Canal, has become connected with J. G. White & Co., Inc., of 43 Exchange Pl., New York City, as Chief Hydraulic Engineer.

Mr. F. O. Sinclair, M. Am. Soc. C. E., has been appointed Superintendent of Water-Works of Burlington, Vt., to succeed Mr. F. H. Crandall, who had held that position for the past 17 years. Mr. Crandall has become associated with Mr. H. M. McIntosh, and they will open an office in Burlington, Vt., and will engage in general engineering work.

Mr. D. L. Ellis, for the past two years City Engineer and Engineer of the Water Department of Great Falls, Mont., retired from that position with the outgoing administration May 1st, and will take up the active management of the Ellis-Ford Pipe Cutter Co., Great Falls, Mont. Mr. George W. Bird, formerly Deputy County Surveyor, will succeed Mr. Ellis in the above positions.

Mr. Frank T. Darrow, for eight years with the Engineering Department of the Chicago, Burlington & Quincy Ry., on the lines west of the Missouri River, with headquarters at Lincoln, Neb., has accepted a position with Mr. Chas. Evan Fowler, M. Am. Soc. C. E., of Seattle, Wash. Mr. Darrow was Division Engineer on the construction of the Chicago, Burlington & Quincy through the Pryor Mountains, in Montana, and was Resident Engineer at Plattsmouth, Neb., during the recent reconstruction of the Burlington bridge across the Missouri River at that point.

Obituary.

William Tod, President of the William Tod Co., of Youngstown, O., died April 27.

Frank Campbell, formerly a prominent contractor and builder of Providence, R. I., died recently in New York City.

James Sutherland, Minister of Public Works in the Cabinet of the Dominion Parliament, died May 3 at Woodstock, Ont.

Richard S. T. Cissell, of Elizabeth, N. J., died May 4 at his home in that city. For the past 15 years he had been President of the Backus Water Motor Co., of Newark, N. J.

John B. Gough, a civil engineer, formerly connected with the City Engineer's office of Providence, R. I., died April 28 in Bishop, Cal. He was a graduate of Massachusetts Institute of Technology, and was about 30 years old.

Charles French Dunbar, a retired contractor of Buffalo, N. Y., died April 30, in that city, of apoplexy, aged 66. He was the inventor of a submarine drill used in dredging rock, and in partnership with Franklin Lee did some of the largest contracting jobs on the Great Lakes.

John W. Booth, a mechanical engineer, in charge of the Ball Engine Works, Philadelphia, died May 1 at his home in that city of rheumatism of the heart. In former years Mr. Booth had been connected with the Gordon Maxwell Pump Works, Hamilton, O.; Smith & Vaile Pump Works, Dayton, O.; and the Wheeling Pump Co., Beloit, Wis. He was 57 years old.

Major Ralph Dunning, one of the oldest retired officers of the United States Army, died May 4 at his home in Brooklyn, N. Y., aged 94. Major Dunning entered the engineering branch of the United States Army when Andrew Jackson was President. He assisted in building the fortifications at Savannah, Charleston, and on the Pacific Coast, and retired from active service about 25 years ago.

Major George Montague Wheeler, a civil engineer of Washington, D. C., died May 3 at his home in that city. Major Wheeler was graduated from West Point in 1866. He was Chief of the Geographical Survey of the United States west of the one hundredth meridian from 1869 to 1879. Major Wheeler retired from the Army because of illness in 1888, and of late years has been a practicing civil engineer in Washington.

ENGINEERING SOCIETIES.

COMING MEETINGS.

INTERNATIONAL RAILWAY CONGRESS.
May 3 to 15, 1905, at Washington, D. C. Secy. of American Committee, W. F. Allen, 24 Park Place, New York.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
May 16, 1905. Annual meeting at New York, N. Y.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
May 17, 18. Annual meeting, at Chattanooga, Tenn. Secy., P. W. Drew, Wisconsin Central Ry., Milwaukee, Wis.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 23 to 25. Annual meeting at New York, N. Y. Secy., W. H. Merrill, Jr.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 6, 7, 8, 9, 1905. Annual spring convention, at Scranton, Pa. Secy., F. R. Hutton, 12 West 31st St., New York, N. Y.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
June 6 to 9, 1905. Annual convention in New York. Secy., Richard Moldenke, Watchung, N. J.

MASTER CAR BUILDERS' ASSOCIATION.
AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 14-21, 1905. Annual meeting at Manhattan Beach, N. Y. Secy., J. W. Taylor, The Rookery, Chicago, Ill.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 19 to 23, 1905. Annual convention at Asheville, N. C. Secy., R. W. Pope, 95 Liberty St., New York, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 20 to 23. Annual convention at Cleveland, Ohio. Secy., Charles Warren Hunt, 220 West 57th St., New York, N. Y.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.
June 29 to July 1. Annual convention at Portland, Oregon. Secy., Milnor Roberts, Seattle, Wash.

LEAGUE OF AMERICAN MUNICIPALITIES.
August 23 to 25. Annual meeting at Toledo, O. Secy., J. McVicar, Des Moines, Ia.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Sept. 5 to 7. Annual meeting at Montreal, Canada. Secy., Geo. W. Tillson, Brooklyn, N. Y.

ROADMASTERS & MAINTENANCE OF WAY ASSOCIATION.
Sept. 12, 14. Annual meeting, at Niagara Falls, N. Y. Secy., C. E. Jones, C., B. & Q. Ry., Beardstown, Ill.

HEALTH OFFICIALS OF MICHIGAN.—A Conference of Health Officials in Michigan will be held under the auspices of the Michigan State Board of Health [illegible] the New Medical Building of the University of M[illegible]n, Ann Arbor, Mich., on June 1 and 2. Dr. F. W. Sh[illegible]ay, Lansing, Mich., is in charge of the arrangements.

ENGINEERS' CLUB OF BALTIMORE.—The or[illegible]za-tion of a local Engineers' Club was completed at a [illegible]st-ing held on April 24 in the Mayor's reception [illegible]m, Baltimore, Md. The following officers were [illegible]d: President, Mr. D. D. Carothers; Vice-Presidents [illegible]rs. A. M. Quick and N. H. Hutton; Secretary, Mr. [illegible] E. Phelps, Jr.; Treasurer, Mr. C. L. Reeder; Di[illegible]rs, Messrs. B. T. Fendall, J. W. Shirley, J. Fisher [illegible] O. Vandervanter, W. T. Manning, and J. H. Harlow.

AMERICAN INSTITUTE OF ELECTRICAL [illegible]GI-NEERS.—The annual meeting of the American I[illegible]tute of Electrical Engineers will be held at Carnegie H[illegible] 154 West 57th St., on Tuesday, May 16th, at 8.15 p. m. The result of the recent election for officers will be an-nounced, and the Secretary and Treasurer will present their Annual Reports. The following papers will then be presented and discussed: "Time-Limit Relays," by George F. Chellis, Interborough Rapid Transit Company, New York; and "The Proper Limit of Duplication to Se-cure Reliability of Service," by H. W. Buck, Niagara Falls Power Company, Niagara Falls, New York.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—This society will hold its annual meeting at Montreal, Canada, Sept. 5, 6 and 7. In connection with this meeting the Associate Members will exhibit materials, apparatus, etc., used in the construction of municipal works, which exhibition it is thought will be the first of its kind to be held on this continent. Only those who are or shall have become Associate Members will contribute to this exhibition. No charges of any kind will be made for floor space, the cost being met by the regular dues; except that where more than a unit space of 5 ft. front by 10 ft. deep is desired, additional spaces of this size may be had at a charge of not to exceed $15 per unit space. Attention is called to the fact that exhibition space may be had free of all charge, because assertions to the contrary have been made in certain quarters. Further particulars may be had by addressing the Secretary, Mr. George W. Tillson, Municipal Building, Brooklyn, N. Y., or the President, Mr. A. Prescott Folwell, Easton, Pa.

NATIONAL FIRE PROTECTION ASSOCIATION.—The ninth annual meeting of this association will be held at the offices of the New York Board of Fire Underwriters, 32 Nassau St., New York, N. Y., on May 23 to 25, 1905. Meetings will be called to order at 10 a. m. each day. The program for Tuesday, May 23, contains, beside some administrative business, the following technical committee reports: Special Hazards and Fire Record, Installation of Automatic Sprinkler Equipments, Fireproof Construction, Electric Fire-Pumps, Standard Thread for Fire-Hose Couplings, and Car Barns. On the following day committees will report on: Private Fire Service Connections to Public Water Supplies, Devices and Materials, High-Pressure Systems for Fire Service, Steam Fire Pumps, Hose and Hydrants, Specifications for the Construction of Oil Rooms, Rotary and Centrifugal Fire Pumps, Indicator Gate and Check Valves, and Factory Standards. The reports to be submitted at the last meeting are: Cement for Building Construction, Theater Construction and Equipment, Uniformity of Requirements, Fire Protecting Coverings for Window and Door Openings, Signaling Systems, Steam Pump Regulators and Auxiliary Pumps, Investigation of the Value of the Steam Jet as an Extinguishing Agent.

GOOD ROADS CONFERENCE.—As noted in our last issue, a Good Roads Conference will be held at Ithaca, N. Y., under the direction of the College of Agriculture of Cornell University, on May 16 to 19. Headquarters will be at the Director's Office, Morrill Hall, on the Campus. Facilities will be provided for the exhibition of roadmaking implements and machinery. The following papers will be read: New York State and Its Transportation Questions," by Mr. W. P. White; "The Good Roads Question, as Seen by the Farmers of New York State," by Mr. W. N. Giles; "The Relation Between Good Roads and the Value of Farm Property, from the Farmer's Point of View," by Mr. F. E. Dawley; "A Good Roads School as the Farmer Sees It," by Mr. J. L. Mandeville; "The Good Roads Question as the Agricultural Editor Sees It," by Mr. G. M. Tucker; "The Good Roads Question as Seen from the State Engineer's Office," by Mr. H. A. Van Alstyne; "The Aesthetic Side of Good Roads Making," by Prof. John Craig; "Highway Improvement, and Laws of New York Governing It," by Mr. F. D. Lyon; "Making Surveys, and Preparation of Plans for Highway Improvement," by Mr. C. W. Trumbull; "How City and Town Will Benefit by Rural Road Improvement," by Mr. H. W. Collingwood; "Recent Highway Legislation in State and Nation," by Mr. A. Warren; "Filling Up Ruts," by Mr. W. G. Johnson; "Advantages of a Course in Highway Construction," by Mr. G. C. Diehl; "Road Transportation and Farm Values," by Mr. W. P. White. Further information about the conference may be had from Prof. L. H. Bailey, College of Agriculture, Cornell University, Ithaca, N. Y.